McDANIEL
COLLEGE

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February 10, 2026

Sanjay K. Rai, Ph.D.
Secretary of Higher Education
Maryland Higher Education Commission
Nancy S. Grasmick Building, 10th Floor
6 N. Liberty Street
Baltimore, MD 21201

Dear Dr. Rai,

On behalf of McDaniel College, I respectfully submit for your review and approval our proposal to establish a Bachelor of Arts in Astronomy within the Department of Physics.

This program reflects both our mission and a clear opportunity in Maryland. For more than 150 years, McDaniel has prepared students for leadership and service through a liberal arts education. The BA in Astronomy builds on that tradition. At present, only one public institution in Maryland offers an undergraduate astronomy degree. Our program expands access to high quality astronomy education within a small, mentoring focused environment that does not currently exist in the state.

The degree is designed to be rigorous and accessible. Grounded in physics, applied mathematics, and computational analysis. This creates a strong pathway into STEM for students who are curious about the universe but may be discouraged by highly abstract mathematics. In doing so, the program advances the State Plan's goals around access, equity, and student success.

Maryland is home to one of the nation's strongest space science ecosystems, including NASA's Goddard Space Flight Center, the Space Telescope Science Institute, and the Johns Hopkins University Applied Physics Laboratory. Our graduates will be prepared for graduate study as well as careers in data science, aerospace research, and science communication. The curriculum emphasizes analytical reasoning, computational skill, and problem solving that align with workforce growth areas in our state's technology and aerospace sectors.

The program is fiscally responsible and strategically aligned. It will launch through the reallocation of an existing faculty line. Enrollment projections indicate it will become revenue positive shortly after launch while strengthening the department overall. Startup costs are modest. We already maintain laboratory space, telescopes, computational infrastructure, and access to research grade telescopes through the Las Cumbres Observatory network.

We are confident that the BA in Astronomy will expand opportunity for Maryland students and strengthen the state's higher education landscape. Thank you for your consideration. I would be glad to provide any additional information you may need.

Sincerely,

Flavius R. W. Lilly, Ph.D.
Provost
McDaniel College

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Cover Sheet for In-State Institutions
New Program or Substantial Modification to Existing Program

Institution Submitting Proposal	McDaniel College

Each action below requires a separate proposal and cover sheet.

- (●) New Academic Program
- ( ) New Area of Concentration
- ( ) New Degree Level Approval
- ( ) New Stand-Alone Certificate
- ( ) Off Campus Program
- ( ) Substantial Change to a Degree Program
- ( ) Substantial Change to an Area of Concentration
- ( ) Substantial Change to a Certificate Program
- ( ) Cooperative Degree Program
- ( ) Offer Program at Regional Higher Education Center

Payment Submitted:	Payment Type:	Payment Amount:	Date Submitted:
(●) Yes ( ) No	( ) R*STARS # (●) Check # 377410	$850	2/12/26

Department Proposing Program	Physics
Degree Level and Degree Type	Bachelor of Arts (BA)
Title of Proposed Program	Astronomy
Total Number of Credits	58 Astronomy; 70 General Education
Suggested Codes	HEGIS: 1911.00 CIP: 40.0201
Program Modality	(●) On-campus ( ) Distance Education (fully online) ( ) Both
Program Resources	(●) Using Existing Resources ( ) Requiring New Resources
Projected Implementation Date (must be 60 days from proposal submisison as per COMAR 13B.02.03.03)	(●) Fall ( ) Spring ( ) Summer Year: 2027
Provide Link to Most Recent Academic Catalog	URL: https://catalog.mcdaniel.edu/index.php
Preferred Contact for this Proposal	Name: Flavius Lilly, PhD Title: Provost Phone: 410-871-3111 Email: FLilly@mcdaniel.edu
President/Chief Executive	Type Name: Julia Jasken, PhD Signature: Julia Jasken Date: 2/16/26
	Date of Approval/Endorsement by Governing Board: 02/07/2026

Revised 4/2025

New Academic Program Proposal

Bachelor of Arts in Astronomy

McDaniel College

Department of Physics

Submitted to the

Maryland Higher Education Commission

January 30, 2026

A. Centrality to Institutional Mission and Planning Priorities

For over 150 years, McDaniel College has been a cornerstone of educational excellence in Maryland, where we have been forging beneficial partnerships with state and local agencies to strengthen the health and vitality of our community. As a distinguished liberal arts college, McDaniel offers a dynamic learning environment where approximately 1,600 undergraduate students and 1,400 graduate students pursue excellence. We offer over 100 innovative undergraduate and graduate degrees, from traditional majors to pre-professional specializations and student-designed pathways, as well as nearly 30 graduate degrees and certificates. Our vibrant and diverse community welcomes students from across Maryland and beyond. These scholars, representing 37 states and 30 countries, bring rich perspectives and experiences to our hilltop campus. We prepare these inquisitive and career-minded students to become engaged citizens and leaders of our region and the world.

Our Mission

McDaniel College is a diverse, student-centered community committed to excellence in the liberal arts and sciences and professional studies. With careful mentoring and attention to the individual, McDaniel changes lives. We challenge students to develop their unique potentials with reason, imagination, and human concern. Through flexible academic programs, collaborative and experiential learning, and global engagement, McDaniel prepares students for successful lives of leadership, service, and social responsibility.[1]

Our First Principles

We strive to place students at the center of a humane environment so that they may see and work toward their personal goals while respecting others and sharing the responsibility for the common good. McDaniel College believes that liberally educated individuals think and act critically, creatively, and humanely. They take charge of their lives and develop their unique potentials with reason, imagination, and human concern. They take their place in the global community, understanding their responsibilities to aid individuals and to contribute to the larger society. McDaniel College accepts the challenge to provide an academic and social environment that promotes liberal learning.

- We provide a foundation of knowledge about the past and present so that students may be informed about the world.
- We provide various approaches to knowledge and personal achievement so that students can think critically about, respond creatively to, and form sensitive, intelligent decisions concerning the world and its future.
- We provide instruction in fundamental skills so that students can express themselves for their own satisfaction and to the larger community.
- We provide solid and respected professional programs for the committed student, and, more important, we provide a liberal arts education as an integral part of professional training so that students will be more flexible, more successful, and happier in the world of work.

In the classrooms, in the residence halls, in the laboratories, on the playing fields, and in the lounges, McDaniel College works to live out these First Principles to support our vision of our college community.

1. Provide a description of the program, including each area of concentration (if applicable), and how it relates to the institution's approved mission.

(a) Description of the program

McDaniel College proposes a new Bachelor of Arts in Astronomy as an expansion of its commitment to liberal arts education. By introducing one of the seven original liberal arts disciplines, astronomy, we are returning to the roots of what it means to provide a comprehensive liberal arts education while positioning McDaniel at the forefront of contemporary STEM education.

We designed the BA in Astronomy to give students a broad foundation in observational astronomy, computational modeling, and data analysis. Students will explore the cosmos through direct observation using telescopes, work with data from ground-based observatories, and engage in theoretical modeling that connects physical principles to cosmic phenomena. The program builds upon McDaniel's existing strengths in physics while creating a distinct pathway for students passionate about space science.

What makes this program distinctive is its accessibility. While maintaining scientific rigor, the BA in Astronomy is intentionally less mathematically intensive than a traditional astrophysics degree, making it approachable for students who are drawn to the wonder of the cosmos, but may not wish to pursue the most quantitative path. This approach broadens access to STEM education, opening doors for students who might double-major in fields like environmental studies, philosophy, computer science, mathematics, or communications.

(b) Relationship of the Proposed BA in Astronomy to McDaniel College's Mission

The proposed BA in Astronomy is a natural extension of McDaniel's mission to provide a student-centered education that combines the rigor of the liberal arts with preparation for meaningful careers. This program will change lives by opening pathways for students who are drawn to the cosmos, but are disinterested in a large research university environment. By offering this degree, we give students the chance to pursue their passion for space science while experiencing close mentorship, intellectual breadth, and student-centered learning that defines McDaniel College.

The astronomy major upholds our First Principles. It places students at the center of a humane learning environment where they can explore their goals while developing critical thinking, creativity, and a sense of responsibility to the larger community. Through observational work with the department's annual membership with the Las Cumbres Observatory's remote telescopic array, hands-on laboratory experiences, and undergraduate research opportunities, students will engage in experiential learning that connects theory to practice. They will learn to think critically about the universe, respond creatively to scientific challenges, and make informed decisions about complex problems, skills that lie at the heart of a liberal education.

In addition to providing students with a foundation of knowledge about the cosmos, this program also places astronomy within its historical and cultural contexts. Many of the field's foundational discoveries originated in the Arab and Islamic world, and the development of astronomy spans cultures, languages, and centuries. By incorporating these perspectives into our courses, we help students see science as a

cumulative and collaborative human endeavor, reinforcing McDaniel's commitment to global engagement and inclusive education.

At the same time, the BA in Astronomy offers solid professional preparation for students interested in careers in space science, data analysis, education, and research. It does so within a liberal arts framework that emphasizes flexibility, adaptability, and lifelong learning. Students will develop fundamental skills in data analysis, computational modeling, scientific writing, and oral communication, competencies that will serve them well in graduate school or in the workforce. The curriculum is intentionally less mathematically demanding than our newly-proposed astrophysics track, making it accessible to a broader range of students, while maintaining strong scientific content. This design reflects our belief that liberal education should empower students to pursue their interests without unnecessary barriers, and that professional training is most successful when integrated with the liberal arts.

Finally, this program aligns with McDaniel's vision of working toward the common good. Astronomy has long been recognized as a visually engaging and intellectually approachable field that draws students into the sciences. By offering this degree, we create opportunities for students who might not otherwise consider a STEM major to discover their potential as scientists and critical thinkers. In doing so, we prepare them not only for professional success but for lives of leadership, service, and social responsibility, which is exactly what our mission calls us to do.

2. Explain how the proposed program supports the institution's strategic goals and provide evidence that affirms it is an institutional priority.

The BA in Astronomy directly supports multiple priorities outlined in McDaniel College Strategic Plan 2022–2027: Reaching New Heights. The plan defines McDaniel as a liberal arts college that "changes lives by inspiring students to achieve educational excellence and realize their potential within a supportive, inclusive, and diverse community." It also calls on the College to be recognized for innovation and student success. The addition of a BA in Astronomy directly advances this vision by expanding access to scientific learning, creating new opportunities for research, and establishing one of the seven original liberal arts disciplines at McDaniel.

Astronomy draws students into STEM through wonder, by inviting them to look up at the night sky and ask fundamental questions about our place in the universe. According to data from our Admissions Office, 204 Maryland high school students indicated an interest in majoring in astronomy or astrophysics, compared to 134 who expressed interest in physics this past year. Nationally, astronomy degrees have experienced remarkable growth. According to the *Roster of Astronomy Departments with Enrollment and Degree Data, 2024* compiled by the American Institute of Physics, 982 astronomy bachelor's degrees were awarded in the 2023-24 academic year, more than double the 459 degrees awarded in 2015.[2]

Crucially, there is only one institution in Maryland, the University of Maryland, College Park (UMD), that currently offers an undergraduate degree in astronomy. By launching this program, McDaniel positions itself to capture a share of this growing market while offering something UMD cannot: personalized mentorship, close faculty-student relationships, and intimate learning environment that define a small liberal arts college. This program is not just about enrollment growth. It is about McDaniel's identity as an innovative institution committed to excellence in STEM education.

3. Provide a brief narrative of how the proposed program will be adequately funded for at least the first five years of program implementation. (Additional related information is required in section L).

The BA in Astronomy will be funded through a combination of institutional reallocation, tuition revenue from new enrollments, and strategic use of adjunct faculty to maintain service courses. The program requires one full-time tenure-track faculty member in astronomy or astrophysics, which represents a conversion of an existing faculty line following the recent departure of our engineering faculty member. This reallocation allows us to sustain our existing physics curriculum while launching the new astronomy program.

A conservative enrollment projection provided by our Admissions Office, suggests the program will become revenue-positive by year four. More importantly, not replacing this faculty position would lead to significant revenue loss, approximately $458,000 after four years, due to our inability to sustain departmental enrollments. The astronomy program, therefore, represents not only a growth opportunity, but also a strategic investment to prevent enrollment decline.

Startup costs are minimal. The Department already possesses several telescopes and observational equipment and has access to research grade telescopes through our annual membership to the Las Cumbres Observatory network. Our existing laboratory spaces and computational resources are sufficient to support the program. The library has adequate holdings in astronomy and physics, supplemented by access to online journals and databases. Detailed financial projections, including revenue and expenditure forecasts, are provided in Tables 1 and 2 in Section L.

4. Provide a description of the institution's commitment to:

(a) ongoing administrative, financial, and technical support of the proposed program

McDaniel College is fully committed to the long-term success of the BA in Astronomy. The College will provide sustained funding for the faculty position, instructional resources, and program operations through the annual departmental budget and targeted capital equipment funding. The Department will have access to existing laboratory and computational infrastructure, and the College will continue to support professional development for faculty through conference travel, workshop attendance, and professional memberships.

(b) continuation of the program for a period of time sufficient to allow enrolled students to complete the program.

McDaniel commits to offering this program for a period sufficient to allow all enrolled students to complete their degrees. The Department has carefully designed a four-year course rotation that ensures students can progress through the major in a timely manner. This rotation guarantees that required courses are offered with predictable frequency. This commitment is strengthened by the College's Finish in Four plan, which combines academic advising, career guidance, and experiential learning opportunities into a structured four-year pathway. Students receive personalized support from faculty advisors and success coaches who help them stay on track toward graduation.

B. Critical and Compelling Regional or Statewide Need as Identified in the State Plan

1. Demonstrate demand and need for the program in terms of meeting present and future needs of the region and the State in general based on one or more of the following:

(a) The need for the advancement and evolution of knowledge

Astronomy sits at the forefront of human knowledge, driving discoveries that reshape our understanding of the universe. From detecting gravitational waves to imaging black holes, from discovering thousands of exoplanets to mapping the cosmic web, astronomy is entering a golden age of observational and computational capability. Maryland plays a central role in this enterprise through institutions like NASA's Goddard Space Flight Center in Greenbelt, the Space Telescope Science Institute in Baltimore (which operates the Hubble and James Webb Space Telescopes), and the Johns Hopkins University Applied Physics Laboratory in Laurel.

The BA in Astronomy prepares students to contribute to this scientific ecosystem. Graduates will have the skills to work in research, data science, aerospace engineering, planetarium education, and science communication, all fields experiencing growth in Maryland and nationwide.

(b) Societal needs, including expanding educational opportunities and choices for minority and educationally disadvantaged students at institutions of higher education

Expanding access to STEM education is a priority for Maryland, particularly for minority and educationally disadvantaged students. Astronomy has unique power to inspire students from all backgrounds. It is a field rooted in curiosity and wonder, requiring no prior specialized knowledge to engage with its fundamental questions. Unlike some STEM disciplines that can feel exclusionary, astronomy invites everyone to look up and wonder.

By making this program accessible to a broader range of students, including those who may not pursue the most mathematically intensive physics tracks, we expand opportunities for students who might otherwise not see themselves in STEM. The program will also strengthen McDaniel's ability to recruit and retain minority students in the sciences, advancing the College's diversity goals.

2. Provide evidence that the perceived need is consistent with the Maryland State Plan for Postsecondary Education.

The BA in Astronomy directly advances the three primary goals of the 2022 Maryland State Plan for Postsecondary Education—Access, Success, and Innovation. It also embodies the State Plan's emphasis on equity and responds to the evolving needs identified in the wake of the COVID-19 pandemic.

Goal 1: Access – Ensuring Equitable Access to Affordable and High-Quality Postsecondary Education

The astronomy program addresses multiple access priorities outlined in the State Plan:

- *Priority 4: Analyze systems that impact how specific student populations access affordable and quality postsecondary education.* As previously stated, UMD is the only institution in Maryland that offers undergraduate astronomy degrees. This creates a significant access barrier for students who

would thrive in a smaller, more personalized learning environment. Research consistently shows that first-generation college students, women in STEM, and students from underrepresented minorities often achieve greater success at institutions offering close faculty mentorship and supportive community structures. McDaniel's BA in Astronomy fills this gap by providing high-quality astronomy education within a liberal arts college setting, expanding access for students who might not succeed at a large research university.

- *Priority 3: Analyze and improve systems that inform and evaluate a student's academic readiness for postsecondary education.* The program is intentionally designed to be less mathematically intensive than traditional astrophysics degrees while maintaining scientific rigor. This accessibility allows students who are passionate about space science, but concerned about advanced mathematics to pursue their interests successfully. By reducing mathematical barriers to entry, we expand the pipeline of students who can access STEM education.
- *Geographic and Financial Access.* Located in Carroll County, McDaniel serves students from Central Maryland, southern Pennsylvania, and surrounding regions who seek residential liberal arts experiences. The program's integration with McDaniel's *Finish in Four* plan helps students graduate on time, reducing overall costs and debt burden, which directly addresses Priority 1's concern of affordability.

Goal 2: Success – Promoting Practices and Policies That Ensure Student Success

The astronomy program embodies several success-oriented priorities:

- *Priority 6: Improve systems that prevent timely completion of an academic program.* The Department has designed a careful four-year course rotation that ensures students can complete the degree on schedule. This structure is reinforced by McDaniel's *Finish in Four* plan, which provides personalized advising, career guidance, and experiential learning support. Students receive individualized attention from faculty advisors and student success coaches, significantly reducing barriers to timely completion.
- *Priority 5: Maintain the commitment to high-quality postsecondary education in Maryland.* The program emphasizes evidence-based pedagogy, hands-on learning through telescopic observations and computational modeling, undergraduate research opportunities, and close faculty mentorship. These high-impact practices are proven to enhance student learning and retention, particularly for underrepresented students in STEM.
- *Priority 7: Enhance the ways postsecondary education is a platform for ongoing lifelong learning.* Astronomy graduates develop transferable skills, such as data analysis, computational modeling, scientific communication, and critical thinking that prepare them for careers that may not yet exist. These competencies support lifelong learning and career adaptability, which is essential to Maryland's rapidly evolving economy.

Goal 3: Innovation – Fostering Innovation to Improve Access and Student Success

- *Priority 8: Promote a culture of risk-taking.* Establishing a BA in Astronomy at a small liberal arts college represents precisely the kind of innovative thinking the State Plan encourages. Rather

than simply replicating what large research universities offer, McDaniel is creating a distinctive model: rigorous space science education delivered within the intimate, mentoring-focused environment of a liberal arts college. This innovation serves students who would not otherwise pursue astronomy while preparing them for Maryland's robust aerospace and data science workforce.

The program also leverages innovative partnerships, potential connections with Maryland's astronomy employers such as NASA Goddard Space Flight Center, Space Telescope Science Institute, and Johns Hopkins Applied Physics Laboratory.

The Equity Lens

The State Plan explicitly calls for all initiatives to be developed through an "equity lens." The BA in Astronomy addresses equity gaps in multiple ways:

- Accessible curriculum design reduces mathematical barriers that disproportionately discourage women and underrepresented minorities from pursuing STEM.
- Culturally responsive content incorporates the history of astronomy across cultures, recognizing contributions from Arab, Islamic, Indian, Chinese, and indigenous astronomers, helping all students see themselves in science.
- Small, supportive learning environment provides the mentorship and sense of belonging that research shows are critical for minority student persistence in STEM.

Response to COVID-19 and Workforce Needs

The State Plan emphasizes remaining "agile and responsive to the changing needs of the workforce." The astronomy program develops competencies such as computational analysis, data science, and scientific programming that align with Maryland's growing technology and aerospace sectors. These skills are transferable across multiple industries, preparing students for workforce demands that continue evolving post-pandemic.

In summary, the BA in Astronomy operationalizes the State Plan's vision by expanding access to high-quality STEM education, implementing evidence-based practices that ensure student success, and fostering innovation in program delivery. Most importantly, it does so through an equity lens, creating pathways for students who have been underserved by current astronomy education options in Maryland.

C. Quantifiable and Reliable Evidence and Documentation of Market Supply and Demand in the Region and State

1. Describe potential industry or industries, employment opportunities, and expected level of entry (ex: mid-level management) for graduates of the proposed program.

Graduates of the BA in Astronomy will be prepared for a wide range of career paths. While some will pursue graduate study in astronomy, astrophysics, or related fields, many will enter the workforce directly in positions that leverage their computational, analytical, and communication skills. Potential career paths include:

- Data analyst or data scientist in technology, finance, or government sectors.
- Software developer or computational scientist.
- Science educator or planetarium director.
- Science communicator or outreach coordinator.
- Research assistant in astronomy, physics, or aerospace engineering.
- Aerospace or defense industry positions (e.g., at NASA Goddard, Johns Hopkins APL, or private contractors).
- Observatory technician or telescope operator.

The positions listed above typically require a bachelor's degree and offer entry at the junior or associate level. While entry-level jobs in the federal government may only require a bachelor's degree, most physicists and astronomers need a PhD for jobs in research and academia. According to the *Occupational Outlook Handbook* compiled the U.S. Bureau of Labor Statistics (BLS), the median annual wage for astronomers was $132,170 in May 2024, while the median for physicists was $166,290.[3] For related fields such as data science and software development, median wages range from $112,590 to $131,450. [4,5]

2. Present data and analysis projecting market demand and the availability of openings in a job market to be served by the new program.

The Bureau of Labor Statistics projects 4% growth in employment for physicists and astronomers from 2024 to 2034, generating approximately 1,800 openings each year. While this is a little higher than the national average of 3%, it tells only part of the story. The real value of an astronomy degree lies not in the narrow job title but in the transferable skills students develop—data analysis, programming, statistical modeling, and scientific communication. These capabilities are in extraordinary demand.

Software developers are projected to grow at 15%, and data scientists—the fourth-fastest growing occupation in the economy—at 34%. Both rates far exceed the national average of 3%. Computer and mathematical occupations are growing at 10%, more than three times the overall economy's rate, driven by demand for AI development, data analysis, and cybersecurity.[6] Our astronomy graduates will be competitive for these roles because the curriculum emphasizes exactly the computational and analytical skills these sectors need.

Maryland offers a robust ecosystem for astronomy-trained professionals that includes:

- NASA Goddard Space Flight Center (Greenbelt, MD) – one of NASA's largest facilities, employing thousands of scientists and engineers,
- Space Telescope Science Institute (Baltimore, MD) – operates the Hubble and James Webb Space Telescopes,
- Johns Hopkins University Applied Physics Laboratory (Laurel, MD) – a leader in space exploration and national security research,
- NOAA's National Environmental Satellite, Data, and Information Service,
- Private aerospace companies and defense contractors with operations in Maryland.

These institutions regularly hire entry-level scientists, data analysts, and technical staff with backgrounds in astronomy and physics. Our proximity to Washington, D.C., creates additional opportunities in federal science agencies, think tanks, and consulting firms that value quantitative training.

The employment picture is strong, the skills are in demand, and the regional opportunities are exceptional. Our students will be well-positioned for success.

3. Discuss and provide evidence of market surveys that clearly provide quantifiable and reliable data on the educational and training needs and the anticipated number of vacancies expected over the next 5 years.

While specific vacancy projections for astronomy positions are limited due to the field's small size, national employment data demonstrates strong and sustained demand for graduates with the quantitative, computational, and analytical skills that astronomy programs cultivate. As mentioned in the previous section, the BLS projects that employment of physicists and astronomers will grow 4% from 2024 to 2034, a little faster than the average for all occupations, with approximately 1,800 openings projected each year over the decade. However, the real story lies not in direct astronomy positions but in the broader occupational landscape where astronomy graduates compete successfully.

The projected growth is quite dramatic in fields that actively recruit individuals with strong quantitative backgrounds. Data science positions are projected to grow 34% from 2024 to 2034, significantly outpacing the 3% average growth rate for all occupations. This represents approximately 23,400 job openings per year and ranks data scientists as the fourth fastest-growing occupation in the economy. Software developer positions, another common career path for astronomy graduates, are projected to grow 15% from 2024 to 2034, with about 129,200 openings per year. Computer and mathematical occupations as a whole are projected to grow 10%, more than three times the average rate of growth for the total economy.

These projections reflect fundamental shifts in the economy. The BLS reports that computer and mathematical occupations constitute the second-fastest-growing occupational group, driven largely by increased demand for artificial intelligence technologies, machine learning, data analysis, and software development capabilities.[6] Astronomy majors are particularly well-positioned to enter these fields because their training emphasizes precisely the skills employers seek: advanced computational modeling, statistical analysis, complex problem-solving, and the ability to work with large datasets.

Employment outcomes data from the American Institute of Physics (AIP) confirm that astronomy graduates transition successfully into high-growth fields. According to AIP's analysis of the classes of

2018, 2019, and 2020, 46% of astronomy bachelor's degree recipients entered the workforce within one year of graduation, with over half working in the private sector and most employed in STEM fields, 47% went to graduate school, and 7% were unemployed.[7] Just over half of astronomy bachelors graduated with double majors, with more than three-quarters of these double majoring in physics, further enhancing their employment prospects.

The median starting salary for astronomy bachelors in private sector STEM positions was $71,000, significantly higher than the $38,000 median for college or university positions. Common job titles for astronomy bachelors in private sector STEM positions included analyst, engineer, and software developer. All respondents in STEM private sector positions indicated they were called upon to solve technical problems at least monthly, demonstrating the direct application of their analytical skills.

Employment data for astronomy PhDs further illustrates career versatility. AIP survey of employment fields for new astronomy PhDs in potentially permanent positions for the classes of 2018, 2019, and 2020 combined show that 33% work in computer software or data science, 19% in engineering or computer hardware, 27% stay in physics and astronomy, 11% in other STEM fields, and 10% in non-STEM fields.[8] As stated before, those entering the private sector commanded substantial salaries in 2024, with the median being $132,170 for astronomers, $166,290 for physicists, $112,590 for data scientists, and $131,450 for software developers.

In general, the professional, scientific, and technical services sector offer particularly strong opportunities for astronomers. This sector is projected to grow 7.5% from 2024 to 2034, driven by heightened needs for cybersecurity expertise, artificial intelligence development, and data infrastructure management.[6] The skills astronomy students develop such as data analysis, programming, statistical modeling, and scientific communication, align precisely with what these expanding sectors need.

4. Provide data showing the current and projected supply of prospective graduates.

As noted earlier, only UMD currently offers an undergraduate degree in astronomy, producing approximately 15–20 astronomy graduates per year. Nationally, 982 astronomy bachelor's degrees were awarded in 2023-24, up from 820 in 2020 and 459 in 2015, according to AIP data.[2] Given the size of Maryland's high school graduating classes and the demonstrated interest in astronomy among prospective students, there is ample room for additional programs.

Last year, 201 Maryland high school students indicated interest in majoring in astronomy or astrophysics, according to data from our Admissions Office. With UMD graduating only 15-20 astronomy majors annually, substantial opportunity exists for McDaniel to attract students seeking this degree path. Since Maryland already exports more students than it retains for higher education, offering another in-state astronomy program within a liberal arts framework would serve both prospective students and the state's broader educational interests.

D. Reasonableness of Program Duplication

1. Identify similar programs in the State and/or same geographical area. Discuss similarities and differences between the proposed program and others in the same degree to be awarded.

Within Maryland, the University of Maryland-College Park (UMD) is the *only* institution offering undergraduate degrees in astronomy. UMD offers both a BA and a BS in Astronomy, as well as a combined BS in Astronomy and Physics. These programs are housed within a large research university with over 40,000 students and are designed primarily to prepare students for graduate study in astronomy or astrophysics.

No other Maryland institution, public or private, research university or liberal arts college, offers a standalone astronomy major. Several institutions offer physics programs with optional astronomy coursework or concentrations, but none offers a degree in astronomy.

2. Provide justification for the proposed program.

The proposed BA in Astronomy at McDaniel College is distinct from UMD's programs in several critical ways:

- **Liberal Arts Focus:** McDaniel's program is designed as a true liberal arts degree. While rigorous, it emphasizes breadth, interdisciplinary connections, and the development of transferable skills. Students will engage with astronomy not just as a technical discipline but as a way of thinking about humanity's place in the cosmos. Also, the students will still have room in their schedules to complete the McDaniel Plan, which are McDaniel's extensive general education requirements.
- **Accessibility:** Our program is intentionally less mathematically intensive than UMD's offerings, making it accessible to students who are passionate about astronomy, but may not wish to pursue advanced graduate study in the field. This opens the door to a broader student population.
- **Personalized Learning Environment:** McDaniel offers small class sizes (upper-division courses in our department typically have fewer that ten students), close faculty mentorship, and a supportive community. Many students, particularly first-generation students, women, and underrepresented minorities, thrive in this environment and may struggle in large research universities.
- **Geographic Accessibility:** McDaniel is located in Carroll County, serving students from Maryland, southern Pennsylvania, and beyond. For students seeking a residential liberal arts experience, McDaniel offers an attractive alternative to College Park.

This program is not duplicative. It serves a distinct market: students who want the intellectual depth of astronomy within the supportive framework of a liberal arts college. By launching this program, McDaniel fills a gap in Maryland's higher education landscape and provides an option that does not currently exist.

E. Relevance to High-demand Programs at Historically Black Institutions (HBIs)

1. Discuss the program's potential impact on the implementation or maintenance of high-demand programs at HBI's.

The proposed BA in Astronomy at McDaniel College will not negatively impact high-demand programs at Maryland's Historically Black Institutions. Neither Bowie State University, Coppin State University, Morgan State University, nor the University of Maryland Eastern Shore currently offers programs in astronomy or astrophysics.

Morgan State University offers a BS in Physics, and Bowie State University offers programs in Computer Science and Engineering. The proposed astronomy program at McDaniel fills a distinct market and will not compete directly with these offerings. Moreover, McDaniel is committed to collaborative relationships with HBIs and would welcome opportunities for course-sharing, faculty collaboration, or student exchanges in the future.

F. Relevance to the identity of Historically Black Institutions (HBIs)

1. Discuss the program's potential impact on the uniqueness and institutional identities and missions of HBIs.

The proposed BA in Astronomy will have no adverse impact on the uniqueness, institutional identities, or missions of Maryland's HBIs. As noted above, none of Maryland's HBIs currently offers astronomy programs, and McDaniel's program targets a distinct student population.

McDaniel is committed to advancing diversity and inclusion in STEM education, goals that align with the missions of HBIs. We welcome opportunities to collaborate with HBIs in ways that strengthen STEM education across Maryland.

G. Adequacy of Curriculum Design, Program Modality, and Related Learning Outcomes (as outlined in COMAR 13B.02.03.10)

1. Describe how the proposed program was established and also describe the faculty who will oversee the program.

The BA in Astronomy emerged from a rigorous, evidence-based planning process led by the Department of Physics faculty. Dr. Shabbir Mian (Department Chair) and Dr. Jeffrey Marx collaborated to design a curriculum that reflects best practices while addressing the specific needs of McDaniel students. The program represents the culmination of over two decades of departmental aspiration, now realized with strong administrative support and strategic alignment with institutional priorities. The 2024–25 external departmental review reinforced the Department's capacity for program expansion and validated the strategic rationale for adding astronomy to McDaniel's academic portfolio.

The curriculum design draws on proven models from distinguished peer institutions, including Lycoming College and Swarthmore College, and follows guidance from the American Astronomical

Society regarding the essential foundations for undergraduate astronomy education; namely, a solid grounding in physics, mathematics, and increasingly, computer science. This careful benchmarking ensures that McDaniel's program prepares students for graduate study or careers in astronomy-related fields while maintaining the accessibility and personalized approach that define liberal arts education.

Dr. Jeffrey Marx brings exceptional credentials to this endeavor. He holds a PhD in physics education research and has developed innovative pedagogical materials for introductory astronomy courses that he has taught over the last two decades. Dr. Marx has also published extensively in peer-reviewed astronomical journals, with research focusing on the physics of double stars and pulsar astronomy. This combination of pedagogical scholarship and active research in astronomy positions him uniquely to design a curriculum that is both scientifically current and pedagogically sound. Finally, he is an active member of the Westminster Astronomical Society. Under his guidance, the program integrates the best of observational astronomy, computational modeling, and theoretical understanding.

Upon program approval, McDaniel will hire a dedicated full-time tenure-track faculty member in astronomy or astrophysics to lead and develop the program. This new colleague will bring specialized expertise in contemporary astronomy or astrophysics, teach core astronomy courses, establish an undergraduate research program, and serve as the primary mentor for astronomy majors. The position will be filled through a national search targeting candidates with demonstrated excellence in both research and undergraduate teaching.

The Department Chair will provide administrative oversight, ensuring the program's integration with departmental operations and institutional strategic planning. All physics faculty will contribute to the program by teaching foundational courses in physics and mathematics that serve as prerequisites for advanced astronomy study. This collaborative model leverages existing departmental strengths while building new capacity in space science education.

2. Describe educational objectives and learning outcomes appropriate to the rigor, breadth, and (modality) of the program.

The BA in Astronomy is designed to develop students' understanding of the universe through observation, theory, and computation. The program goes beyond content mastery to cultivate transferable skills—critical thinking, quantitative reasoning, scientific communication, and computational proficiency—that prepare students for diverse career paths in research, education, data science, and beyond. Our learning outcomes reflect best practices in undergraduate astronomy education.

Program Learning Outcomes

Upon completion of the BA in Astronomy, students will be able to:

1. **Demonstrate a deep understanding of the scientific endeavor**, including the nature of scientific inquiry, the development of physical theories, and the role of evidence in advancing knowledge. Students will understand how astronomy exemplifies the scientific method through observation, hypothesis formation, and theoretical modeling.
2. **Apply strong critical thinking and quantitative reasoning skills** to solve complex problems in astronomy and related fields. Students will develop the analytical capacities necessary to

interpret astronomical phenomena, evaluate competing explanations, and make evidence-based conclusions.

3. **Demonstrate fundamental knowledge of core astronomical concepts**, including celestial mechanics, stellar evolution, and galactic structure. Students will understand the physical principles governing cosmic phenomena from planetary systems to the large-scale structure of the universe.
4. **Communicate scientific ideas effectively** through oral presentations and written reports, tailored to both technical and general audiences. Students will learn to translate complex astronomical concepts for diverse stakeholders, an essential skill for careers in research, education, and science communication.
5. **Use astronomical instrumentation proficiently**, including hands-on and remote telescopes, detectors, and data analysis software, to collect and analyze observational data. Students will gain hands-on experience with the tools and techniques that drive modern observational astronomy.
6. **Apply computational methods** to analyze astronomical data, model physical systems, and test hypotheses. Students will develop programming skills and learn to work with large datasets, preparing them for careers in data science, software development, and computational research.
7. **Recognize the historical and cultural contexts of astronomical discovery** and appreciate astronomy as a global, collaborative human endeavor. Students will understand that astronomy's foundational contributions come from diverse cultures—including Arab, Islamic, Indian, Chinese, and indigenous societies—and will see science as an inclusive, multicultural enterprise.

These learning outcomes ensure that graduates are not only knowledgeable about astronomy, but also equipped with the intellectual flexibility, technical competence, and communication skills necessary for lifelong learning and professional success in an evolving workforce.

3. Explain how the institution will:

(a) provide for assessment of student achievement of learning outcomes in the program

Student learning outcomes will be assessed through multiple methods at the course, program, and institutional levels, with each assessment tool designed to evaluate specific learning outcomes.

Course-level assessment

Astronomy courses will include some combination of assignments, exams, laboratory reports, and projects designed to assess specific learning outcomes. Faculty will use detailed rubrics to evaluate student performance consistently across the following dimensions.

- **Outcomes 1-3 (scientific inquiry, quantitative reasoning, astronomical concepts):** Assessed through problem sets, exams, and laboratory reports that require students to apply physical principles, interpret data, and solve complex astronomical problems.

- **Outcome 4 (scientific communication):** Assessed through written lab reports, research papers, and oral presentations evaluated using rubrics that measure clarity, technical accuracy, and audience appropriateness.
- **Outcome 5 (instrumental proficiency):** Assessed through hands-on laboratory activities, observational projects using telescopes, and data collection exercises that demonstrate competency with astronomical equipment and software.
- **Outcome 6 (computational methods):** Assessed through programming assignments, computational modeling projects, and data analysis tasks using Python, MATLAB, or specialized astronomy software.
- **Outcome 7 (historical and cultural contexts):** Assessed through discussion participation, and assignments that examine astronomy's development across cultures and time periods.

Capstone assessment

All astronomy majors complete a senior capstone project (AST 4491) in which they conduct an independent research investigation, analyze data, and present their findings. This capstone serves as a culminating assessment integrating multiple learning outcomes:

- Students demonstrate mastery of **Outcomes 1-3** by formulating research questions, designing investigations, and applying astronomical knowledge.
- They showcase **Outcome 4** through a written research paper and oral presentation to faculty and peers.
- They apply **Outcomes 5-6** by utilizing observational or computational methods appropriate to their research topic.
- Where applicable, students may incorporate **Outcome 7** by contextualizing their research within astronomy's historical development.

Embedded assessments

Key courses throughout the curriculum will include specific assignments designed to measure student progress on learning outcomes at critical junctures:

- AST 1111 (Principles of Astronomy) includes pre- and post-assessments measuring foundational knowledge **(Outcome 3)** and understanding of scientific inquiry **(Outcome 1)**.
- AST 2112 (Observational Astronomy) includes practical examinations of instrumental proficiency **(Outcome 5)**.
- Upper-level electives assess advanced quantitative reasoning **(Outcome 2)** and computational skills **(Outcome 6)**.

External benchmarking

The Department will periodically compare student performance against national benchmarks, such as results from the Physics and Astronomy Graduate Record Examination (GRE), to evaluate the program's effectiveness in developing foundational knowledge **(Outcome 3)** and quantitative reasoning skills **(Outcome 2)**.

(b) document student achievement of learning outcomes in the program

Documentation of student achievement will be systematically maintained and organized according to program learning outcomes.

Learning Outcome 1 (Scientific inquiry):

- Course grades in core astronomy and physics courses
- Capstone project proposals demonstrating understanding of scientific methodology
- Faculty assessments of students' ability to formulate testable hypotheses
- Embedded assessment results from AST 1111

Learning Outcome 2 (Critical thinking and quantitative reasoning):

- Performance on problem sets and exams across all astronomy courses
- Physics GRE scores (when available)
- Rubric scores from quantitative analysis assignments in upper-level courses

Learning Outcome 3 (Core astronomical knowledge):

- Course grades and exam scores in astronomy coursework
- Comprehensive assessment embedded in capstone projects
- Pre/post-test results from AST 1111 comparing knowledge at program entry vs. completion

Learning Outcome 4 (Scientific communication):

- Rubric scores from oral presentations throughout the curriculum
- Evaluation of written lab reports, research papers, and capstone documents
- Peer and faculty feedback on presentation effectiveness

Learning Outcome 5 (Instrumental proficiency):

- Laboratory practical examinations in AST 2112 and observational competency assessments
- Observational logs and telescope operation records
- Faculty evaluations of hands-on skills during research projects

Learning Outcome 6 (Computational methods):

- Programming assignments and computational project grades
- Assessment of data analysis competency in capstone projects and upper-level coursework
- Faculty evaluation of coding proficiency in relevant courses

Learning Outcome 7 (Historical and cultural contexts):

- Written reflections and discussion contributions
- Assessment results from assignments addressing astronomy's multicultural history
- Exit survey responses regarding appreciation of astronomy as a global endeavor

Comprehensive documentation systems

- **Course-level:** Transcript records and graded assignments with rubric scores.
- **Program-level:** Capstone project reports and presentations archived in the Department.
- **Institutional-level:** Annual program assessment reports submitted to the College's Academic Assessment Committee, mapping assessment results to each learning outcome.
- **Post-graduation:** Exit surveys administered to graduating seniors; alumni surveys conducted 2-3 years post-graduation assessing career outcomes, graduate school success, and perceived preparedness across all learning outcomes.

The Department Chair will compile assessment data annually, organizing results by learning outcome. Faculty will review aggregated data during departmental meetings to identify strengths and areas for improvement. Results will inform curriculum modifications, pedagogy enhancements, resource allocation decisions, and strategic planning for program development.

4. Provide a list of courses with title, semester credit hours and course descriptions, along with a description of program requirements

The BA in Astronomy requires 54 credit hours, distributed as follows:

Core Courses (24 credits in physics and 8 credits in mathematics):

Course	Title	Credits
PHY 1000	Bosons to Bridges to Black Holes	4
PHY 1114 + PHY 1014	General Physics I and Lab	4
PHY 1115 + PHY 1015	General Physics II and Lab	4
PHY 2201 + PHY 2001	Mathematical Physics and Lab	4
PHY 2202	Intermediate Mechanics	4
PHY 2203	Foundations of Modern Physics I	4
MAT 1117	Calculus I	4
MAT 1118	Calculus II	4

Required Astronomy Courses (14 credits):

Course	Title	Credits
ASR 1111	Principles of Astronomy	4
ASR 2115 or ASR 2110	Observational Astronomy OR Galactic Astronomy	4

Course	Title	Credits
PHY 2209	Investigations I	1
PHY 3309	Investigations II	1
ASR 4491	Senior Capstone	4

Electives (8 credits):

Students select two elective courses (8 credits total) from physics, mathematics, chemistry, or computer science. Options include:

Course	Title	Credits
CSC 1106	The Art of Programming	4
CHE 1103 + CHE 1001	General Chemistry I and Lab	4
CHE 1104 + CHE 1002	General Chemistry II and Lab	4
PHY 2212	From Lenses to Lasers	4
PHY 3301	Intermediate Electricity and Magnetism	4
PHY 3311	Thermodynamics	4
PHY 4401	Quantum Mechanics	4
MAT 2219	Calculus III	4
MAT 2218	Linear Algebra	4
MAT 3304	Differential Equations	4

Departmental Writing (4 credits):

All students in the Department of Physics take PHY 3200: Advanced Physics Laboratory to fulfill the College's Writing in the Discipline requirement and are not included in the credit count for the major.

Course Descriptions

PHY 1000 – Bosons to Bridges to Black Holes (4 credits)

Drawing examples from astronomy, physics, and engineering, this course will introduce students to foundational physical principles in the areas of statics, dynamics, fluids, and thermodynamics, as well as topics at the forefront of science. In-class activities will help reinforce those concepts while improving students' understanding of experimental design, estimation, and data analysis. This course also will connect basic mathematics concepts to the physical sciences, while also introducing and applying more advanced mathematical topics.

PHY 1114 + PHY 1014 – General Physics I and Lab (4 credits)

This course is the first in the two-semester, calculus-based, general physics sequence. The course will introduce students to kinematics and dynamic motion for linear, rotational, and oscillatory systems; concepts of energy and momentum; and wave phenomena, sound, and fluids. The laboratory component

of the course (PHY 1014) is aimed at developing data collection and analysis skills through a series of experiments in mechanics. The laboratory must be enrolled in separately.

PHY 1115 + PHY 1015 – General Physics II and Lab (4 credits)

This is the second course in the two-semester, calculus-based, general physics sequence. In this course we cover thermodynamics, the fundamental ideas of electricity and magnetism, the influence of electromagnetic fields on particles, Maxwell's equations, circuits and circuit analysis, light, and geometric and physical optics. The laboratory component of the course (PHY 1015) is aimed at developing data collection and analysis skills through a series of experiments in thermodynamics, electromagnetism, and optics. The laboratory must be enrolled in separately.

PHY 2201 + PHY 2001 – Mathematical Physics and Lab (4 credits)

This fundamental course for physic majors and minors serves to introduce many of the mathematical tools and ideas needed to solve problems describing physical systems. Topics include integration and differentiation, vector calculus, series, complex analysis, matrices, differential equations, and Fourier analysis. The one-hour per week laboratory component of the course is aimed at familiarizing students with Mathematica.

PHY 2202 – Intermediate Mechanics (4 credits)

This course covers classical Newtonian and Lagrangian mechanics as applied to the motion of particles and systems. Specific topics include solutions to Newton's laws in the presence of retarding forces; conservation theorems; harmonic, damped, and forced oscillations, and resonance phenomena; phase-space diagrams; gravity and gravitational potential; Hamilton's principle, Lagrange's and Hamilton's equations of motion, and generalized coordinates; central force motion and orbits in a central field; linear and angular momentum of a system of particles; and the dynamics of rigid bodies and the moments of inertia.

PHY 2203 – Foundations of Modern Physics I (4 credits)

This course introduces student to the foundations of modern physics by studying the experimental and theoretical breakthroughs of great physicists such as Einstein, Bohr, Schrödinger, and Rutherford, to name a few. Topics include special relativity, the wave and particle nature of light and matter, and elementary quantum theory applied to simple systems such as a particle in a box, tunneling, and the hydrogen atom. This course includes an integrated laboratory component to help students develop strong links between theory and practice.

PHY 2209 – Investigations I (1 credit)

This course is intended to offer students a formal opportunity to engage in the creative process of putting forward and resolving their own physics questions, which is one of the great things about being a physicist! Investigations have three parts. First, each student must think of and carefully word an interesting question to delve into; then work toward an answer for the Investigation question and, as time permits, any collateral questions that develop from the main line of inquiry; and, finally, compile a report based on the findings of the Investigation and make a short presentation to the class. Investigation

questions can be related to any realm of physics that is of personal interest, and projects that merge multiple domains are encouraged.

PHY 3309 – Investigations II (1 credit)

This is the second course in the Investigation sequence. The structure of this course is the same as Investigations I, with the expectation that the quality of the Investigation will be higher. As in the first course, Investigation questions can be related to any realm of physics that is of personal interest, and students may choose to develop further on previous Investigation projects. Students are free to enroll in this course as many times as they wish, with each successive enrollment appearing on a student's transcript as a separate class.

PHY 2212 – From Lenses to Lasers (4 credits)

Optics is an influential branch of physics that deals with the origin and propagation of light as well as it interaction with matter. In this course, students will study how and why optical phenomena occur. We will cover theories that treat light as a bundle of rays (ray optics), as electromagnetic waves (wave optics), and as a stream of particles (quantum optics). We will explore phenomena of reflection, refraction, dispersion, scattering, polarization, interference, and diffraction in terms of these theories. Students will learn about the limitations of ray optics, the improvements in wave optics, and the triumph of quantum optics leading to the study of the laser. This course includes an integrated laboratory component to help students develop strong links between theory and practice.

PHY 3200 – Advanced Physics Laboratory (4 credits)

This course will introduce students to advanced skills and analysis techniques essential to gaining a real understanding of how physics is done in the laboratory. Specific laboratories will be based on topics from Mechanics, Modern Physics, and E&M, and may also introduce new and exciting areas from the world of physics. Additionally, this course will also establish for students writing and presentation skills critical to communicating in the field of physics. The writing and presentation component of this course will be tightly coupled to the laboratory component.

PHY 3301 – Intermediate Electricity and Magnetism (4 credits)

This course involves a detailed investigation of Maxwell's equations. Specific topics include applications of Gauss' law; Poisson and Laplace's equations; boundary conditions problems; electric displacement and polarization; dielectrics; Ampere's and Biot-Savart law; scalar and vector potentials; magnetic fields in matter; diamagnetic, paramagnetic and ferromagnetic materials; Faraday's law; electromagnetic induction; energy in electric and magnetic fields; and solutions of Maxwell's equations.

PHY 3311 – Thermodynamics (4 credits)

Understanding thermodynamics means understanding how energy is allocated in systems from the very simple to the complex. This course covers the laws of thermodynamics, equations of state, thermodynamic potentials, and classical and quantum statistics of gases. At all points of this course, we will consider the connections between theory and application. Specific topics include ideal gases;

chemical systems and equilibrium; energy, work, engines and entropy; spin and magnetic systems; and phase transitions.

PHY 4401 – Quantum Mechanics (4 credits)

In this course, students will investigate the origins of quantum theory, the Schrödinger equation, physical interpretations of quantum mechanics, and solutions to one- and three-dimensional problems including spin. Topics include solving the time-dependent and time-independent Schrödinger equation, development of the uncertainty principle, solutions for the infinite and finite square well problems, study of the harmonic oscillator and free particle solutions. A large part of the course is devoted to developing the formalism of Quantum Mechanics, wavefunctions as vectors in Hilbert spaces, eigenfunctions and eigenvalues of operators, commutators of operators and the Dirac notation. Solutions are obtained for the hydrogen problem in 3-D, including the study of the angular momentum and spin operators.

ASR 1111 – Principles of Astronomy (4 credit)

This foundational course for astronomy and astrophysics majors will introduce majors to the fundamental physical principles and observational techniques essential for understanding our universe, with a focus on developing the skills and knowledge for advanced study in astronomy. Topics will include fundamental physics, the classification of celestial objects, and stellar evolution. Additionally, students will learn about astronomical observational methods and instrumentation.

ASR 2110 – Galactic Astronomy (4 credit)

Galaxies serve as a fundamental building block of our universe. This course aims to build a comprehensive picture of galaxies through developing an understanding of the physical principles that govern galactic phenomena, and the methods astronomers use to study them. Topics will include galactic structure; evolution; dynamics and interactions; and denizens, such as stars, pulsars, quasars, interstellar medium, and black holes.

ASR 2115 – Observational Astronomy (4 credit)

Astronomy is fundamentally an observational science, and this course introduces students to various observational techniques that involve subatomic particles, electromagnetic radiation, and gravitational waves. Emphasis is placed on the physical principles underlying gravitational distortions of space-time, sub-atomic particles, and electromagnetic emissions, as well as ground and space-based telescope design, detectors, experimental techniques, and data analysis.

ASR 4491 – Senior Capstone (4 credit)

The senior capstone immerses students in research in astronomy or astrophysics. Projects may involve independent investigation or contribute to an ongoing faculty-led research effort. Students will engage in observational or experimental studies using astronomical data and instrumentation or pursue theoretical and computational modeling to interpret astrophysical phenomena. The capstone culminates in a written research paper and an oral presentation to the department.

MAT 1117 – Calculus I (4 credits)

Initial study of limits, derivatives and integrals; review of trigonometric functions; differentiation techniques and formulas applied to rational and trigonometric functions; applications of derivatives including curve sketching; extrema and rate problems; definition of the integral; elementary applications of integrals.

MAT 1118 – Calculus II (4 credits)

Further study of the trigonometric, exponential, and logarithmic functions and their derivatives, methods of integration; parametric equations; polar coordinates; sequences, infinite series, and power series.

MAT 2219 – Calculus III (4 credits)

A study of functions of several variables. Topics include partial derivatives, directional derivatives, multiple integrals, the structure of Euclidean n-space, En, functions from Em to En, line and surface integrals, Green's and Stokes' Theorems.

MAT 2218 – Linear Algebra (4 credits)

A study of the theory of finite-dimensional vector spaces, linear transformations, matrices, determinants, inner products, and eigenvalues.

MAT 3304 – Differential Equations (4 credits)

Linear differential equations with applications in the physical, biological, and social sciences; series solutions; systems of linear differential equations; approximation methods; the Laplace transform; Fourier series; the heat equation.

CHE 1103 + CHE 1001 – General Chemistry I and Lab (4 credits)

This course is the first fundamentals course in chemistry. The course is designed for students majoring in STEM fields with a sufficiently strong math background. The course includes the following topics: discussion and application of the scientific method; properties of matter; structure of the atom and periodic table; introduction to creating solutions and dilutions; fundamentals of chemical reactions; basics of thermochemistry; development of quantum theory, atomic theory, and the basics on bonding theory; and application of chemical concepts to biology and health fields. Students will apply the knowledge they learn in this course to the required course CHE-1001 by performing experiments to practice analytical skills and solidify knowledge through concrete examples and real-world problem solving. Course includes a 3-hr laboratory.

CHE 1104 + CHE 1002 – General Chemistry II and Lab (4 credits)

The second half of the two-semester, general chemistry sequence is designed primarily for those students who are interested in majoring in the sciences and have sufficiently solid backgrounds in science and mathematics to allow for a more in-depth investigation of the field. The course starts with an overview of the physical properties of solids, liquids and gases and how they can be interpreted using kinetic molecular theory. Major topics also include an introduction to chemical kinetics, the principles of chemical equilibrium, and chemical thermodynamics. Finally, a detailed study of two important classes

of reactions, acid-base and reduction-oxidation, will be covered. In the laboratory, students explore gases, solutions, kinetics, and equilibrium, using conventional and instrumental techniques, applying their skills in a problem-solving environment.

CSC 1106 – The Art of Programming (4 credits)

An introduction to the use of algorithms for problem solving. The course will focus on finding algorithmic solutions for a given problem and expressing these solutions in a programming language. This course includes a laboratory.

5. Discuss how general education requirements will be met, if applicable.

McDaniel College requires all students to complete 128 credits for graduation, including general education requirements known as the McDaniel Plan. The McDaniel Plan embodies our commitment to liberal arts education, requiring approximately 50-55 credits distributed across multiple categories: First-Year Seminar, writing, quantitative reasoning, natural sciences, social sciences, humanities, global perspectives, and experiential learning. This structure ensures that all graduates, regardless of major, develop the breadth of knowledge, critical thinking skills, and cultural awareness essential for engaged citizenship and lifelong learning.

The BA in Astronomy is intentionally designed to integrate seamlessly with the McDaniel Plan, allowing students to fulfill general education requirements efficiently while pursuing their passion for space science. The astronomy major naturally satisfies several McDaniel Plan categories through its core curriculum.

- **Quantitative Reasoning:** Students fulfill this requirement through the calculus sequence (MAT 1117 and MAT 1118), which provides the mathematical foundation necessary for advanced work in astronomy and physics. These courses develop not only computational skills but also logical reasoning and abstract thinking, competencies that transfer across disciplines and careers.
- **Natural Sciences:** The astronomy major exceeds this requirement through multiple physics and astronomy courses that engage students in scientific inquiry, experimental design, and evidence-based reasoning. Students learn to ask questions about the natural world, design investigations to answer those questions, and interpret results critically, the hallmarks of scientific literacy.
- **Writing in the Discipline:** Scientific communication is a core competency for astronomy graduates. Formally, all students in our department will fulfill this graduation requirement by taking PHY 3200: Advanced Laboratory. Furthermore, students will develop disciplinary writing skills through laboratory reports, research papers, and the senior capstone project. These assignments teach students to communicate complex technical information clearly, precisely, and persuasively.
- **Experiential Learning:** Astronomy is inherently experiential. Students engage in hands-on telescope observations, computational modeling projects, laboratory experiments, and independent research. Through partnership with the Westminster Astronomical Society, students gain access to observing sites and equipment that transform abstract concepts into tangible discoveries. Many students will also pursue internships at institutions like NASA Goddard Space

Flight Center, the Space Telescope Science Institute, or other Maryland astronomy employers, further enriching their experiential learning.

- **Interdisciplinary Connections:** The remaining general education requirements—humanities, social sciences, arts, and global perspectives—are fulfilled through elective coursework outside the major. Far from being burdensome, these requirements enhance the astronomy major by fostering interdisciplinary thinking. Our graduates will not only understand celestial mechanics and stellar evolution but also appreciate astronomy's cultural significance, communicate across disciplines, and think critically about science's role in society.

Academic advisors will work closely with astronomy students from their first semester to ensure efficient progress toward both major and general education requirements. The four-year course rotation is carefully designed to allow students to balance major coursework with general education courses each semester, preventing bottlenecks and ensuring timely graduation. Through McDaniel's *Finish in Four* plan, students will receive personalized guidance from faculty advisors and student success coaches who will help them navigate requirements, explore connections between disciplines, and make intentional choices about their educational pathways.

The result is a degree program that honors McDaniel's liberal arts mission while preparing students for specialized careers in astronomy, related fields, and STEM careers, in general. Our graduates will possess both technical expertise and the broad intellectual foundation necessary for leadership, adaptability, and lifelong learning.

6. Identify any specialized accreditation or graduate certification requirements for this program and its students.

There are no specialized accreditation requirements for undergraduate astronomy programs. The program is designed to meet standards consistent with recommendations from the American Astronomical Society and the American Association of Physics Teachers.[9] Graduates will be well-prepared for graduate study in astronomy, astrophysics, or related fields, as well as for careers requiring strong quantitative and analytical skills.

7. If contracting with another institution or non-collegiate organization, provide a copy of the written contract.

Not applicable. McDaniel College will not contract with other institutions for this program.

8. Provide assurance and any appropriate evidence that the proposed program will provide students with clear, complete, and timely information on the curriculum, course and degree requirements, nature of faculty/student interaction, assumptions about technology competence and skills, technical equipment requirements, learning management system, availability of academic support services and financial aid resources, and costs and payment policies.

McDaniel College is deeply committed to transparency and student success. We recognize that informed students make better decisions and achieve greater academic and career outcomes. The BA in Astronomy

will be fully integrated into McDaniel's existing communication infrastructure, ensuring that all prospective and current students have access to clear, complete, and timely information throughout their educational journey.

College Catalog – The Authoritative Source

The BA in Astronomy will be included in the official McDaniel College catalog upon approval. Published annually and available online with searchable functionality, the catalog will provide detailed information on complete curriculum requirements, including all required courses, electives, and credit hour totals. Each course listing will include a course description with listed prerequisites. Students can access current and archived catalogs, ensuring they understand the specific requirements applicable to their year of admission.

Department Website – Dynamic and Student-Centered

The Physics Department website will feature a dedicated page for the astronomy program that will include a four-year course plan detailing how students will progress through the major. The website will showcase research opportunities, provide data on career pathways and graduate school options, and feature testimonials as alumni become available. A comprehensive FAQ section will address common questions, and the site will provide contact information for immediate inquiries and links to relevant campus resources.

McDaniel Portal and Self-Service – Real-Time Academic Information

Students and advisors have access to McDaniel's internal portal system, which includes Self-Service functionality. Through Self-Service, students can view their academic records in real-time, including courses taken, grades earned, and remaining requirements for both the major and general education. This transparency allows students to monitor their own progress toward degree completion and come to advising meetings well-informed about their academic standing. The system clearly displays which astronomy major requirements have been fulfilled and which remain outstanding, eliminating confusion about degree progress.

EAB Navigate – Proactive Advising and Student Success

Both students and advisors have access to EAB Navigate, a comprehensive student success platform that facilitates proactive advising and support. Through Navigate, advisors can schedule appointments, send reminders, track student engagement, and identify students who may need additional support. Students use Navigate to schedule advising appointments, receive personalized notifications about important deadlines, and access resources tailored to their needs. This system enables early intervention when students face challenges and ensures consistent communication between students and their support network.

Academic Advising – Personalized Guidance

Every astronomy major will be assigned a dedicated faculty advisor who will serve as their primary academic mentor throughout their time at McDaniel. Students will meet with their advisors at least once per semester before course registration, ensuring they stay on track for timely graduation. During the first

advising meeting, students and advisors will develop a four-year plan showing how they will complete major requirements, general education, and electives efficiently. Advisors will provide holistic guidance on academic goal setting, career exploration, graduate school preparation, internship opportunities, and undergraduate research. The combination of personal advising relationships, Self-Service access, and EAB Navigate ensures no student falls through the cracks.

New Student Orientation – Setting the Stage for Success

McDaniel's First-Year Experience, coordinated through the Office of Academic Life, provides comprehensive transition support through New Student Orientation, first-year seminars, the Peer Mentor program, and ongoing programming for academic and social engagement. Prospective astronomy majors will visit campus during Admitted Student Days to meet physics faculty, tour laboratories and observing facilities, and speak with current students. During New Student Orientation, incoming astronomy majors will receive detailed program presentations including curriculum overviews, faculty introductions, and four-year course plans, while also connecting to people, places, and programs through a "one-stop" approach. Each new student is paired with a peer mentor through First-Year Seminars who serves as their FYS Guide, while their faculty advisor in the Physics Department provides discipline-specific guidance, creating a dual support system that builds a strong foundational base for success at McDaniel.

Learning Management System – Blackboard

McDaniel uses Blackboard as its learning management system. All astronomy courses will utilize Blackboard as the central hub where students access course syllabi, readings, assignments, grades, and announcements. The platform enables communication between students and faculty through messaging and discussion boards. Blackboard also allows students to view their grades in real-time throughout the semester. Faculty receive comprehensive Blackboard training through the Office of Instructional Design and Technology (InTech), and students receive Blackboard tutorials during orientation with access to round-the-clock technical support.

Academic Support Services

McDaniel provides extensive academic support services to ensure students can succeed in any program. The Writing Center employs trained tutors who can help students with research papers, lab reports, and capstone projects. The Pick STEM Center offers peer and professional tutors who assist with mathematics, physics problem-solving, and quantitative analysis—all critical skills for astronomy success. Hoover Library's reference librarians provide research consultations and teach information literacy skills essential for scientific research. The Office of Academic Life houses success coaches who work with students on time management, study strategies, and learning skills. Students with documented disabilities receive appropriate accommodation through our Student Academic Support Services (SASS office).

Financial Aid Information

More than 90% of McDaniel students receive some type of financial assistance, with the College investing nearly $55 million annually in need-based grants and merit scholarships.[10] Throughout the admissions process, students work with their own admissions counselor who helps them plan campus visits and apply for admission, scholarships, and financial aid. Upon admission, each student is assigned a

Financial Aid Specialist who works with them throughout their four years at McDaniel, allowing the specialist to understand their personal financial situation and how it changes over time. Financial aid specialists help students understand available opportunities including grants, scholarships, student loans, and work-study programs. Prospective students can estimate their actual out-of-pocket costs using an online net price calculator, and complete information on tuition, fees, and expenses is published online and updated annually. Students can schedule 30-minute virtual meetings with financial aid specialists to discuss their specific circumstances, explore funding options, and understand how the *Finish in Four* plan helps reduce overall costs through timely graduation.

Technology Competence and Equipment

The astronomy program will make explicit the technology competencies students will develop and the equipment they will need. Students are expected to arrive with basic computer literacy, but no prior programming experience. The curriculum will build computational skills progressively, beginning with basic programming. Students have full access to and use of departmental computers but may want to purchase a personal laptop for convenience. McDaniel will provide free access to any software students need through campus licenses. All observational equipment including telescopes, digital imaging equipment, and spectroscopic instruments will be provided by the department.

Through McDaniel's established communication infrastructure, students will have the information they need, when they need it, in formats that meet their diverse preferences. This commitment to transparency reflects our student-centered values and directly supports our goals of timely degree completion, student satisfaction, and post-graduation success.

9. Provide assurance and any appropriate evidence that advertising, recruiting, and admissions materials will clearly and accurately represent the proposed program and the services available.

McDaniel College adheres to rigorous standards for accuracy and transparency in all marketing and recruiting materials. The College's Communications and Marketing Office works closely with academic departments to ensure that program descriptions, promotional materials, and web content accurately reflect curriculum, faculty expertise, facilities, and outcomes.

All admissions materials undergo review by the Provost's Office and relevant department chairs before publication. The College is committed to ethical recruiting practices and full compliance with federal and state regulations governing higher education advertising.

H. Adequacy of Articulation (as outlined in COMAR 13B.02.03.19)

1. If applicable, discuss how the program supports articulation with programs at partner institutions. Provide all relevant articulation agreements.

The BA in Astronomy is designed to support seamless transfer pathways for students from Maryland community colleges, particularly Carroll Community College (CCC), our closest community college partner. We have also adopted a Block Transfer Policy that ensures students entering with an Associate of

Arts (A.A.), Associate of Science (A.S.), or Associate of Arts in Teaching (A.A.T.) from an accredited U.S. institution will have met all McDaniel general education requirements (the McDaniel Plan). This policy allows transfer students to focus immediately on completing their astronomy major requirements upon arrival at McDaniel.

McDaniel and Carroll Community College signed a Dual Admissions Agreement (also called Transfer Plus) in 2022 that allows students who complete 30 credits at Carroll to apply to the program, with McDaniel accepting all Carroll Community College coursework for transfer up to 64 credits as agreed upon by a McDaniel advisor. Under this agreement, students receive access to a McDaniel advisor for academic planning to ensure alignment with their proposed transfer program, and the McDaniel advisor collaborates with the Carroll advisor to coordinate degree requirements.

Students who complete appropriate coursework at community colleges will receive full credit toward the astronomy major. Specifically, students who complete the following courses at Maryland community colleges will have those credits apply directly to astronomy degree requirements:

- **Calculus I and II** (equivalent to MAT 1117, MAT 1118)
- **Calculus-based General Physics I and II** with laboratories (equivalent to PHY 1114/1014, PHY 1115/1015)
- **General Chemistry I and II** with laboratories (if taken as electives, equivalent to CHE 1103/1001, CHE 1104/1002)
- **Computer Science/Programming** courses (equivalent to CSC 1106)
- **General education courses** that fulfill McDaniel Plan requirements

We will work closely with Carroll Community College and other Maryland community college partners to develop clear transfer pathways as the program matures. The Physics Department has experience developing articulation agreements with Carroll Community College, having recently established agreements for students interested in physics as well as electrical, mechanical, and civil engineering. We will apply this collaborative approach to create explicit astronomy transfer pathways that specify which community college courses satisfy astronomy major requirements.

McDaniel participates in the Maryland Independent College and University Association (MICUA) consortium working with Maryland's 16 community colleges to create comprehensive transfer pathways that focus on clear communication, shared data analysis, and removing roadblocks to student success.[11] This participation ensures that McDaniel remains committed to accessible transfer processes for community college students across the state.

We are committed to making the astronomy program accessible to transfer students and ensuring smooth transitions into the major. As the program develops, we will formalize additional articulation agreements as needed to support transfer student success. Transfer students will receive the same personalized advising, faculty mentorship, and access to research opportunities as students who begin at McDaniel as first-year students.

I. Adequacy of Faculty Resources (as outlined in COMAR 13B.02.03.11)

1. Provide a brief narrative demonstrating the quality of program faculty. Include a summary list of faculty with appointment type, terminal degree title and field, academic title/rank, status (full-time, part-time, adjunct) and the course(s) each faculty member will teach in the proposed program.

The BA in Astronomy will be supported by highly qualified faculty with expertise in physics, astronomy, and related fields.

Dr. Jeffrey D. Marx

Professor Marx brings a unique and compelling combination of scholarly accomplishment, pedagogical innovation, and entrepreneurial vision that positions him exceptionally well to teach and develop an undergraduate astronomy program. With a Ph.D. in Physics from Rensselaer Polytechnic Institute and twenty-five years of teaching at McDaniel College, where he advanced from Assistant Professor to Full Professor and served as Department Chair from 2014 to 2024, Dr. Marx has demonstrated both the leadership capacity and institutional commitment needed to build programs from the ground up.

His scholarly work spans three distinct but complementary areas that directly support astronomy education: physics education research, where he has published extensively in broad-reaching journals like *The Physics Teacher* and the *American Journal of Physics*; pulsar astrophysics, where he collaborates on cutting-edge research using the 20-meter and 100-meter radio telescopes at the National Radio Observatory; and double-star astrometry, where he employs advanced techniques like such as bypassing single-image diffraction limits through narrow, band-pass imaging to study close-separation binary systems. This constellation of expertise, combining deep pedagogical knowledge with active observational astronomy research, makes Dr. Marx uniquely positioned to create an astronomy program that balances rigorous theoretical foundations with hands-on research experiences.

His track record of curricular innovation is particularly impressive: he designed *From Bosons to Bridges to Black Holes*, an entirely novel preparatory course for physics students; created the two-semester *Investigations in Physics* sequence that gives students authentic research experiences; developed *Eclipse 2024!*, a special topics course culminating in an expedition to witness the total solar eclipse; and has consistently incorporated research-based teaching strategies informed by the latest findings in physics education research.

Beyond his scholarly credentials, Dr. Marx has proven himself adept at securing external funding and building research infrastructure. He served as co-principal investigator on a funded grant proposal to use the 100-meter radio telescope at Greenbank, one of the world's premier astronomical facilities, and has

previously secured NSF grants totaling over $300,000 to develop innovative science courses. He has also established a granular physics laboratory on campus, demonstrating his ability to create hands-on research spaces where students can engage in authentic scientific investigation.

His commitment to student mentorship runs deep: he has directed nearly 50 student-faculty research projects, supervised independent investigations, and consistently involved undergraduates as co-authors on presentations at national meetings. His service on the Editorial Board of The Physics Teacher, his invited presentations at national AAPT meetings, and his 15+ peer-reviewed publications (some are highly cited) demonstrate that he remains actively engaged in both the astronomy research community and the physics education community.

Most importantly, Dr. Marx possesses the vision and determination needed to launch new programs in competitive higher education landscapes. His long-standing advocacy for astronomy at McDaniel, proposing an astronomer hire seven consecutive years between 2003 and 2009, reflects both persistence and genuine conviction that space science education matters. With Dr. Marx at the helm, an undergraduate astronomy program would not simply exist on paper but would thrive as a vibrant, research-active, pedagogically innovative pathway that attracts passionate students and prepares them for successful careers in science.

Dr. Shabbir Mian

Professor Mian brings a rare combination of deep research expertise, extensive teaching experience, and proven institutional leadership that makes him exceptionally well-qualified to teach and develop an undergraduate astronomy program. With a Ph.D. in Physics from Oklahoma State University and over twenty-five years at McDaniel College, where he has served as both Professor and Department Chair for multiple terms, Dr. Mian has demonstrated the sustained commitment and administrative capability needed to build successful programs.

His research credentials are particularly impressive: he has published over 30 peer-reviewed papers in prestigious journals including the *Journal of the Optical Society of America*, *Applied Physics Letters*, and *Advanced Materials*; secured over $225,000 in external grants from the National Science Foundation and the Petroleum Research Fund; and established a vibrant undergraduate research program that has supervised more than 30 senior capstone projects leading to collaborative publications and professional presentations. His core expertise lies in nonlinear optics, spectroscopy, and photonic materials, fields that provide essential foundations for understanding light and electromagnetic radiation. Dr. Mian's research has consistently bridged fundamental physics with practical applications, a perspective that translates naturally to astronomy education where students must connect theoretical principles to observational phenomena. His collaborations with institutions like University College London, Oxford University, and Cambridge University demonstrate his ability to work within international research networks, while his work on organic light-emitting diodes, photonic crystals, and spectroscopy provides the kind of rigorous training in optical physics that underlies modern astronomical instrumentation and detection methods.

Beyond his research accomplishments, Dr. Mian has proven himself to be an innovative and dedicated educator who stays current with physics education research and implements evidence-based teaching practices. He redesigned McDaniel's *General Physics* sequence to incorporate Interactive Lecture

Demonstrations and Tutorials, demonstrating measurable improvements in student learning through pre- and post-instruction surveys. He created an *Advanced Physics Laboratory* course that teaches students error analysis, data handling, and scientific ethics while fulfilling the College's writing requirement, which is exactly the kind of rigorous, research-oriented training astronomy students need. As Principal Investigator on an NSF grant, he developed *A World of Light and Color*, a discovery-based general science course that employs hands-on activities to teach students about optics and optical phenomena, showing his ability to make complex physics accessible to diverse student populations. His development of online courses in *Understanding the Universe* and *Introductory Astronomy* demonstrates direct experience teaching astronomical content.

Dr. Mian's extensive committee service, including chairing the Faculty Development Committee, chairing the provost search committee, and serving on the General Education Taskforce, shows his commitment to pedagogy and institutional improvement. He secured a dual-degree engineering partnership with the McKelvey School of Engineering at Washington University, St. Louis, in 2019 and is currently serving as McDaniel's engineering director. He has written four articulation agreements with Carroll Community College and currently is on their Science Advisory Board and Engineering Advisory Board, demonstrating his ability to create external connections that benefit students. With Dr. Mian's leadership, an astronomy program would benefit not only from his deep understanding of the physics of light and optical systems, the very foundation of observational astronomy, but also from his track record of securing funding, mentoring student researchers, and building programs that attract and retain talented students while maintaining the highest standards of academic rigor.

Upon approval of the program, McDaniel will hire one full-time, tenure-track faculty member in astronomy or astrophysics. This faculty member will hold a PhD in astronomy, astrophysics, or a closely related field and will have demonstrated excellence in teaching, research, and mentorship.

Current Faculty:

Name	Degree/Field	Rank	Status	Courses Taught in Program
Shabbir Mian	PhD, Physics	Professor	Full-time	PHY 1000, PHY 2203, PHY 3200, PHY electives
Jeffrey Marx	PhD, Physics	Professor	Full-time	PHY 1114, PHY 1115, PHY 2202, PHY 2209, PHY 3309, PHY electives
[To Be Hired]	PhD, Astronomy or Astrophysics	Assistant Professor	Full-time	PHY 1000, PHY 1014, PHY 1015, PHY 2201, PHY 2202, AST 1111, AST 2111, AST 2112, AST 3111, AST 4491

Mathematics faculty will teach calculus that is required for the major. They hold terminal degrees in their respective fields and have extensive teaching experience.

2. Demonstrate how the institution will provide ongoing pedagogy training for faculty in evidenced-based best practices, including training in:

(a) Pedagogy that meets the needs of the students

McDaniel College is committed to supporting faculty development in evidence-based pedagogical practices. InTech at McDaniel College offers training on best practices in online and hybrid teaching and learning, Blackboard training and support, training on Microsoft 365 collaboration tools, faculty workshops, instructional guides and tutorials, and individual consultations on any technology-oriented topics.

(b) The learning management system

The College provides comprehensive training in Blackboard, our learning management system. Training includes workshops for new faculty, ongoing support from instructional technology staff, and online resources. Faculty teaching astronomy courses will have full access to Blackboard features including online assignment submission, grade management, discussion boards, and multimedia content integration.

(c) Evidenced-based best practices for distance education, if distance education is offered.

The BA in Astronomy will be an on-campus program. However, should circumstances require remote instruction (as during public health emergencies), faculty will have access to training in online teaching through InTech. McDaniel successfully transitioned to remote instruction during the Covid-19 pandemic and has retained institutional knowledge and resources to support high-quality online learning.

J. Adequacy of Library Resources (as outlined in COMAR 13B.02.03.12)

1. Describe the library resources available and/or the measures to be taken to ensure resources are adequate to support the proposed program.

Hoover Library at McDaniel College has comprehensive resources to support the BA in Astronomy. The library's collections include both print and electronic resources in physics and astronomy, ensuring students and faculty have access to the materials necessary for a rigorous astronomy program.

Current Holdings

The library maintains an extensive collection of print and electronic books across all disciplines, including physics and astronomy. The library provides access to electronic books through multiple database vendors and platforms. These collections cover a variety of disciplines including business, economics, technology, engineering, humanities, arts, and science, enabling interdisciplinary research that connects astronomy to other fields.

Current holdings include approximately 487,000 books (print and electronic), 121,000 media titles (physical and electronic), 183,000 electronic journals (subscribed and open source), and access to 135 online databases. The Physics collection includes essential reference works such as the CRC Handbook of

Chemistry and Physics, Encyclopedia of Condensed Matter Physics, and McGraw-Hill Encyclopedia of Science and Technology, as well as specialized volumes in aeronautics and astronomy.

Electronic Resources

Students and faculty have comprehensive access to electronic journal collections in physics and astronomy and databases through both on-campus and off-campus access. The library maintains an A-Z Database List and a dedicated physics research guide that provides access to relevant databases, journals, and websites for physics and astronomy research.

Database access includes:

- JSTOR for access to scholarly journals and primary sources across disciplines
- ProQuest databases (10 different collections providing broad coverage of scientific literature)
- Springer journal and eBook collections
- IOPScience for physics research
- Science Direct for scientific journal articles
- PubMed for biomedical literature
- Sage Journals and Project Muse

Students and faculty also have access to publicly available resources that are essential for astronomy research:

- arXiv.org preprint server for cutting-edge physics and astronomy research
- DOAJ and DOAB for open-access books and journals across multiple disciplines
- NASA's extensive online archives and data repositories, including data from major space missions
- OSTI.gov (Office of Scientific and Technical Information) portal for Department of Energy research and development results
- ComPADRE Digital Library network for physics and astronomy education resources

Interlibrary Loan Services

Materials not available in the library's collection can be requested through interlibrary loan services, a free service providing access to resources from other institutions through Maryland's statewide library consortium and national interlibrary loan networks. As part of the Carroll Library Partnership, Hoover also provides access to materials from Carroll County Public Library and Carroll Community College through a shared catalog system, significantly expanding the resources available to McDaniel students and faculty. McDaniel College students and faculty also have borrowing privileges at participating libraries at institutions in the Maryland Independent Colleges and Universities Association (MICUA).

Support for New Programs

A dedicated STEM, Instruction & Assessment Librarian works directly with academic departments to ensure collections meet curricular needs. As the astronomy program develops, the library will evaluate collection gaps and acquire additional resources as needed. The library's commitment to supporting new

academic programs is demonstrated through its established processes for collection development and its responsiveness to faculty requests.

The College commits ongoing funding for library acquisitions to support this and other academic programs. This financial commitment ensures that the astronomy program will have access to current resources, including new publications, databases, and technological tools as they become available and relevant to the curriculum.

K. Adequacy of Physical Facilities, Infrastructure and Instructional Equipment (as outlined in COMAR 13B.02.03.13)

1. Provide an assurance that physical facilities, infrastructure and instruction equipment are adequate to initiate the program, particularly as related to spaces for classrooms, staff and faculty offices, and laboratories for studies in the technologies and sciences.

McDaniel College possesses adequate physical facilities, infrastructure, and instructional equipment to support the BA in Astronomy. The Department of Physics is housed on the third floor of Lewis Hall of Science, a well-equipped floor with modern classrooms, laboratories, and faculty offices.

Facilities include

- **Classrooms:** Multiple teaching spaces equipped with projection systems, whiteboards, and multimedia capabilities.
- **Physics laboratories:** Dedicated teaching laboratory spaces for introductory and advanced physics courses, including modern experimental equipment for mechanics, optics, electricity and magnetism, and modern physics.
- **Computer laboratory:** Computational facilities with workstations running Windows and computational software including Python, MATLAB, Mathematica, and specialized astronomy software.
- **Research laboratories:** A granular physics laboratory with a shaker and sound vibration isolation walls; a nonlinear optics and spectroscopy laboratory with an assortment of continuous wave and pulsed lasers, spectrometers, detectors and optics; and an empty laboratory space for the new astronomy or astrophysics faculty.
- **Faculty offices:** Private offices for all full-time faculty and common area for meetings.

Astronomical Equipment

The Department owns and maintains the following astronomical observational equipment:

- Reflector telescopes: three 6-inch, three 8-inch, and one 10-inch aperture telescopes. The 10-inch, an 8-inch, and a 6-inch have computerized mounts and tracking systems
- A dedicated solar telescope (refractor), equipped with a narrow, band-pass hydrogen-alpha filter
- A dedicated refractor for astrophotography
- Several digital imagers for astrophotography and photometry

- Spectroscopic equipment for analyzing stellar spectra

Additional we have the following resources available to us:

- Access to a local dark-sky observing site with a 14-inch telescope housed in an observatory run by Westminster Astronomical Society. A current member of the physics faculty is certified to operate the telescope.
- Account with the Las Cumbres Observatory (LCO). The LCO is a world-wide, remote telescope array offering students and faculty access to research-grade optical telescopes.

The College is committed to maintaining and upgrading equipment as needed. Capital funding is available for equipment purchases, and the Department regularly applies for external grants to support instrumentation improvements.

2. Provide assurance and any appropriate evidence that the institution will ensure students enrolled in and faculty teaching in distance education will have adequate access to:

(a) An institutional electronic mailing system, and

All McDaniel students, faculty, and staff have access to institutional email through Microsoft Office 365. Email accounts are created upon admission/hire and remain active throughout enrollment/employment.

(b) A learning management system that provides the necessary technological support for distance education

McDaniel uses Blackboard as its learning management system. Blackboard provides comprehensive support for course delivery, including assignment management, discussion forums, grade books, multimedia content hosting, and video conferencing integration. While the BA in Astronomy is designed as an on-campus program, Blackboard is used to supplement face-to-face instruction and would support remote learning if needed.

L. Adequacy of Financial Resources with Documentation (as outlined in COMAR 13B.02.03.14)

1. Complete Table 1: Resources and Narrative Rationale.

The following table presents projected resources for the first five years of program implementation. All figures are in current dollars and are based on conservative enrollment projections provided by the Admissions Office.

Table 1: Program Resources

Resource Categories	Year 1	Year 2	Year 3	Year 4	Year 5
	AY 27-28	**AY 28-29**	**AY 29-30**	**AY 30-31**	**AY 31-32**
1. Reallocated Funds	$104,000	$106,080	$108,202	$110,366	$112,573
2. Tuition/Fee Revenue (c + g below)	$0	$47,840	$98,550	$126,884	$156,828
a. Number of F/T Students	0	2	4	5	6
b. Annual Tuition/Fee Rate	$23,000	$23,920	$24,638	$25,377	$26,138
c. Total F/T Revenue (a x b)	$0	$47,840	$98,550	$126,884	$156,828
d. Number of P/T Students	0	0	0	0	0
e. Credit Hour Rate	$1,661	$1,727	$1,779	$1,833	$1,888
f. Annual Credit Hour Rate	N/A	N/A	N/A	N/A	N/A
g. Total P/T Revenue (d x e x f)	$0	$0	$0	$0	$0
3. Grants, Contracts & Other External Sources	$0	$0	$0	$0	$0
4. Other Sources	$0	$0	$0	$0	$0
TOTAL (Add 1 – 4)	**$104,000**	**$153,920**	**$206,752**	**$237,249**	**$269,401**

Narrative Rationale for Resources:

Reallocated Funds: The program will launch with a strategic reallocation of existing resources rather than requiring new institutional funding. Following the recent departure of the engineering faculty member from the Department, the College has approved converting this line into an astronomy position. This realignment serves dual purposes: it allows the College to attract a new group of students to space science while freeing current departmental faculty to develop the Engineering Mechanics program. The starting salary for this position is budgeted at $80,000 with $24,000 in benefits (30% of salary), increasing by 2% annually. This approach enables program launch without additional financial burden to the institution.

Tuition and Fees: Revenue projections reflect a measured growth trajectory: two new majors in Year 1, two in Year 2, three in Year 3, and three in Year 4, reaching a steady-state enrollment of approximately six students by Year 5 (two students per cohort across three upper-level years). These projections are

deliberately conservative and account only for net new enrollments directly attributable to the astronomy program—students who would not otherwise have chosen McDaniel.

After student financial aid, net tuition and fees amount to $23,000 per student annually. We have applied a 4% increase for Year 2, then 3% annually thereafter to account for standard tuition adjustments. While the current credit hour rate for part-time students stands at $1,661 (increasing at the same rate as annual tuition), we do not anticipate part-time enrollment in this program and have therefore excluded it from revenue calculations.

Grants and Contracts: The Department will actively pursue external funding for research, equipment, and student support through NSF, NASA, and private foundations. However, the astronomy program's financial sustainability does not depend on securing these grants. The program is designed to operate independently of external funding, with grant support serving to enhance rather than sustain operations.

2. Complete Table 2: Program Expenditures and Narrative Rationale.

Table 2: Program Expenditures

Expenditure Categories	Year 1	Year 2	Year 3	Year 4	Year 5
	AY 27-28	**AY 28-29**	**AY 29-30**	**AY 30-31**	**AY 31-32**
1. Faculty (b + c below)	$104,000	$106,080	$108,202	$110,366	$112,573
a. Number of FTE	1	1	1	1	1
b. Total Salary	$80,000	$81,600	$83,232	$84,897	$86,595
c. Total Benefits	$24,000	$24,480	$24,970	$25,469	$25,978
2. Admin. Staff (b + c below)	$0	$0	$0	$0	$0
a. Number of FTE	0	0	0	0	0
b. Total Salary	$0	$0	$0	$0	$0
c. Total Benefits	$0	$0	$0	$0	$0
3. Support Staff (b + c below)	$0	$0	$0	$0	$0
a. Number of FTE	0	0	0	0	0
b. Total Salary	$0	$0	$0	$0	$0
c. Total Benefits	$0	$0	$0	$0	$0
4. Technical Support and Equipment	$20,000	$15,000	$10,000	$10,000	$10,000
5. Library	$4,000	$4,160	$4,326	$4,499	$4,679
6. New or Renovated Space	$0	$0	$0	$0	$0
7. Other Expenses	$7,000	$7,000	$7,000	$5,000	$5,000
TOTAL (Add 1 – 7)	**$135,000**	**$132,240**	**$128,528**	**$124,865**	**$126,252**

Narrative Rationale for Expenditures

Faculty Salaries: The astronomy/astrophysics position will be funded through reallocation of an existing faculty line vacated by the recent departure of our engineering faculty member. The College will hire a full-time tenure-track astronomer or astrophysicist with a starting salary of $80,000 and $24,000 in benefits, increasing by 2% annually. Existing physics faculty will teach core courses required for the major as part of their regular teaching assignments, ensuring efficient use of current resources.

Administrative and Support Staff: No additional administrative or support staff are required. The Department Chair and existing College administrative staff will provide all necessary support.

Equipment: The College has committed substantial resources to ensure the astronomy program launches with the tools necessary for success. We have allocated $25,000 for Year 1 and $15,000 for Year 2 to establish the program infrastructure, followed by $10,000 annually for ongoing programmatic support. These funds will cover an annual $5,000 subscription to Las Cumbres Observatory—a global network of research-grade optical telescopes that will provide students and faculty with professional-level observational capabilities. Initial startup expenses in Years 1 and 2 include astronomical software licenses, telescopes, optical filters, spectrometers, and CMOS cameras. Following this initial investment, a modest annual equipment budget of $5,000 will support maintenance and incremental upgrades to telescopes, computers, and laboratory equipment. While the College may consider additional observational facilities in the future, the program does not depend on new construction or capital projects.

Library Resources: The College has allocated $4,000 to expand library holdings in space science, including new books, journal subscriptions, and specialized database access. This allocation will increase by 4% annually to maintain currency in this rapidly evolving field.

Marketing and Recruitment: As with any new program, initial investment in visibility is essential. The College has budgeted $7,000 for Years 1, 2, and 3 to develop marketing materials, enhance web presence, and support targeted recruitment efforts. This expenditure will decrease to $5,000 annually once the program becomes established and generates momentum.

Financial Sustainability

The program is projected to become revenue-positive by Year 4, when tuition revenue from astronomy majors will exceed program-specific expenditures. Beyond direct revenue generation, this program addresses a more fundamental institutional challenge: it prevents revenue loss from our inability to sustain engineering enrollments with only two faculty members. By hiring an astronomer, we free our existing faculty to develop and staff the Engineering Mechanics major—a program that currently attracts 20-25 students annually through our engineering specialization and dual-degree partnership with Washington University. The astronomy program thus represents not merely a new revenue stream, but a strategic intervention that secures both space science and engineering as viable, growing programs at McDaniel. Without this investment, we risk losing both opportunities.

M. Adequacy of Provisions for Evaluation of Program (as outlined in COMAR 13B.02.03.15)

1. Discuss procedures for evaluating courses, faculty and student learning outcomes.

McDaniel College maintains comprehensive systems for evaluating courses, faculty performance, and student learning outcomes. The BA in Astronomy will be evaluated using established institutional processes:

Course Evaluation

All courses are evaluated each semester through student course evaluations. Students provide anonymous feedback on course content, teaching effectiveness, workload, and learning environment. Results are reviewed by the Department Chair and used in faculty performance evaluations and course improvement planning. Additionally, the Department conducts periodic curriculum reviews to ensure courses remain current and aligned with program goals.

Faculty Evaluation

Faculty performance is evaluated through multiple measures:

- Student course evaluations
- Department Chair evaluation
- Self-evaluation and reflection on teaching, research, and service
- Review of scholarly productivity and professional development

Tenure-track faculty undergo formal reviews in years 2, 4, and 6, with comprehensive evaluation of teaching, research, and service. Tenured faculty are reviewed periodically for promotion and post-tenure review.

Student Learning Outcomes Assessment

Student learning outcomes are assessed through the process described in Section G. The Department will collect and analyze data on student performance in key courses and capstone projects. Results are reported annually to the College's Academic Assessment Committee.

2. Explain how the institution will evaluate the proposed program's educational effectiveness, including assessments of student learning outcomes, student retention, student and faculty satisfaction, and cost-effectiveness.

Program evaluation will be ongoing and systematic, using multiple metrics:

- **Student Learning Outcomes:** Annual assessment of student performance on program learning outcomes through capstone projects, portfolio reviews, and embedded assessments in key courses.
- **Student Retention:** Tracking of retention rates from first year to graduation, comparison with institutional averages, and analysis of factors contributing to attrition.

- **Student Satisfaction:** Exit surveys for graduating seniors, alumni surveys at 1-2 years post-graduation, and ongoing feedback through advising meetings.
- **Faculty Satisfaction:** Annual faculty surveys and regular department meetings to discuss program development, challenges, and opportunities.
- **Graduate Outcomes:** Tracking of graduate school acceptance rates, employment outcomes, and career satisfaction.
- **Cost-Effectiveness:** Annual review of program finances including revenue, expenditures, and cost per student.

The Department will compile an annual assessment report summarizing findings and recommending improvements. Every five years, the program will undergo comprehensive external review by visiting consultants, consistent with McDaniel's practices for program review.

N. Consistency with the State's Minority Student Achievement Goals (as outlined in COMAR 13B.02.03.05)

1. Discuss how the proposed program addresses minority student access & success, and the institution's cultural diversity goals and initiatives.

McDaniel College is deeply committed to promoting diversity, equity, and inclusion in all academic programs, and the BA in Astronomy will advance these goals in several important ways.

Expanding Access to STEM

Astronomy has unique power to engage students from diverse backgrounds. Unlike some STEM disciplines that may feel exclusionary, astronomy invites everyone to wonder about the cosmos. The program's deliberate emphasis on accessibility—through reduced mathematical prerequisites compared to astrophysics—will broaden participation among students who might otherwise not see themselves in physics or engineering.

Research shows that women and underrepresented minorities are more likely to persist in STEM when they feel a sense of belonging and connection to the material. Astronomy, with its visual beauty, cultural significance, and existential questions, creates those connections. By offering this program, McDaniel expands pathways for minority students to enter and succeed in STEM fields.

Culturally Responsive Curriculum

The astronomy curriculum will explicitly incorporate the history of astronomy across cultures. Many foundational concepts in astronomy—from star catalogs to algebraic methods to observational techniques—originated in the Arab and Islamic world, India, China, and indigenous cultures worldwide. By teaching astronomy as a truly global, multicultural endeavor, we help all students see themselves reflected in the history of science.

Institutional Support for Minority Students

McDaniel maintains several programs to support minority student success:

- **Academic Skills Center:** Provides tutoring, study groups, and academic coaching with particular attention to first-generation and underrepresented students.
- **STEM Scholars Program:** Provides mentorship, summer research opportunities, and academic support for students pursuing STEM majors, with emphasis on recruiting minority students.
- **Cultural Centers:** Including the Center for Experience and Opportunity and other affinity spaces where students find community and support.
- **Financial Aid:** Dedicated scholarships for underrepresented students, including the Hering Scholarship for students of color.

The astronomy program will actively partner with these offices to recruit and support minority students. Faculty will receive training in inclusive pedagogy and culturally responsive teaching, and the Department will track diversity metrics to ensure equitable access and success.

O. Relationship to Low Productivity Programs Identified by the Commission

1. If the proposed program is directly related to an identified low productivity program, discuss how the fiscal resources (including faculty, administration, library resources and general operating expenses) may be redistributed to this program.

The proposed BA in Astronomy is not directly related to any low productivity programs identified by the Maryland Higher Education Commission. The program represents a new major that builds upon existing strengths in physics while creating a distinct academic pathway for students interested in space science.

The program does, however, represent a strategic reallocation of resources following changes in departmental capacity. With the recent departure of our engineering faculty member, the College approved conversion of this faculty line to support new programs in astronomy and engineering mechanics. This reallocation ensures the Department maintains sufficient faculty to deliver its curriculum while launching new programs that respond to student demand.

P. Adequacy of Distance Education Programs (as outlined in COMAR 13B.02.03.22)

1. Provide affirmation and any appropriate evidence that the institution is eligible to provide Distance Education.

McDaniel College is authorized to offer distance education and has established comprehensive infrastructure to support high-quality online and hybrid instruction. Most of the College's graduate programs are offered as online or hybrid programs, where most or a large portion of courses are delivered in a virtual classroom using Blackboard Learn. The College serves approximately 1,200 graduate students across more than 20 master's degree and certificate programs, with many programs available entirely online or in a blended format combining online and in-person instruction. These

programs deliver courses using both asynchronous and synchronous learning modalities, providing flexibility for working professionals while maintaining academic rigor.

The College's distance education infrastructure centers on Blackboard, the institutional learning management system that supports all online and hybrid courses. Upon admission, all students receive a McDaniel email account with single sign-on access to Blackboard, enabling seamless integration with other institutional systems. The College maintains robust technical support through its Help Desk, which operates Monday through Friday during business hours, and is supplemented by after-hours support available weeknights and throughout weekends. This ensures that distance learners have consistent access to technical assistance regardless of when they are completing coursework.

Faculty development for online teaching is comprehensive and ongoing. InTech provides training and support to faculty in the use of current and emerging learning technologies. InTech offers instruction on best practices in online teaching and learning, Blackboard training and support, and specialized training for off-campus faculty. The office includes dedicated staff focused on instructional design and digital pedagogies, Blackboard technical support, and course evaluation support. Faculty teaching online or hybrid courses receive training aligned with Quality Matters standards, ensuring that courses meet nationally recognized benchmarks for online course design and delivery. The College also subscribes to Infobase, an online learning portal that includes over 5,000 video tutorials on software applications and instructional topics, providing additional professional development resources for faculty.

The College maintains clear policies regarding student identity verification, academic integrity, and support services for distance learners. Students enrolled in hybrid or online courses have the same access to academic advising, library resources, technical support, and student services as those in traditional face-to-face courses. Our Hoover Library provides 24/7 access to electronic resources, including databases, e-books, and research assistance, ensuring that distance learners can complete coursework effectively regardless of their physical location.

All course proposals, whether face-to-face, hybrid, or online, undergo the same rigorous approval process through the College's curriculum review process. This ensures that learning outcomes, assessment methods, and academic rigor remain consistent across all delivery modalities.

During the COVID-19 pandemic, the College successfully transitioned all courses to remote delivery while maintaining academic standards and student support services, demonstrating institutional capacity and faculty readiness for distance education at scale.

2. Provide assurance and any appropriate evidence that the institution complies with the C-RAC guidelines, particularly as it relates to the proposed program.

McDaniel College is committed to meeting all applicable standards for distance education quality, including the C-RAC (Council of Regional Accrediting Commissions) guidelines. McDaniel also complies with State Authorization Reciprocity Agreement (SARA) guidelines through Maryland's participation in the National Council for State Authorization Reciprocity Agreements (NC-SARA). The College's accreditation by the Middle States Commission on Higher Education further demonstrates our commitment to maintaining quality standards for all instructional modalities. We regularly review and

update our policies and practices to ensure continued compliance with both accreditation standards and best practices in distance education, including those outlined in the C-RAC guidelines.

However, the BA in Astronomy is designed as an on-campus residential program. Astronomy requires hands-on laboratory work, observational experiences with telescopes, and close mentorship relationships between students and faculty, all of which are best accomplished through in-person instruction. While Blackboard may be used to supplement face-to-face teaching with course materials, discussion forums, and assignment management, the program will not be offered as a distance education program. The residential nature of this program aligns with the pedagogical requirements of astronomy education and ensures students gain the practical, observational, and collaborative skills essential for success in the field. Should circumstances require temporary remote instruction (as during public health emergencies), the College has systems and policies in place to ensure compliance with all applicable regulations.

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