

## Application for Mildred Dahne Award Department of Physics – Spring 2018

The TCNJ Department of Physics promotes a culture of intellectual engagement centered on the natural sciences. Physics faculty are teacher-scholars, dedicated to excellence in teaching and to the production and dissemination of new knowledge. The community of faculty and students studies phenomena that span amazing scales, ranging from nanometers to the size of the universe. They conduct research in atmospheric physics, biophysics, physics education, geophysics, materials science, optics, plasma physics, astronomy, astrophysics and cosmology. Through a deep commitment to developing the critical thinking and problem solving skills of our students, the physics department ultimately prepares them to excel in a wide array of careers and to be informed and engaged citizens.

By its nature, physics and physics education are not static enterprises, and constant reflection and assessment are necessary to reach *our goal of departmental excellence at a national level*. A series of internal and external reviews over the past 6 years, followed by careful planning and active program revision have indeed resulted in national recognition for the TCNJ physics department. Consider the comments from the external review teams that evaluated the physics department in 2012 and in 2017:

*“The undergraduate program offered by the TCNJ physics department in many ways matches the standard U.S. criteria for “thriving” physics programs. The faculty are extraordinarily successful in their instructional roles and all department personnel are focused on the success of the program and their students, coupled with a strong commitment to the future of the physics program from the administration.” (2012)*

*“As in the last program review, the TCNJ physics department has sustained an outstanding undergraduate program. The faculty have continued to be extraordinarily successful in their instructional roles and all department personnel are focused on the success of the program and their students. The Department has maintained an impressive record of scholarly accomplishments from among its faculty and students while its curriculum prepares students for a variety of physics-related careers in industry, secondary education, or graduate work in physics or a related discipline.” (2017)*

Since 2012, the department has undergone a series of personnel transitions, curricular innovation, and laboratory development, all with the singular purpose of continuing to improve upon the already thriving environment noted by the external review teams. In 2018, the department believes it is indeed a signature program for TCNJ, characterized by a sustained history of teaching excellence, academic excellence, and student involvement.

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### Teaching Excellence

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The TCNJ physics department offers an educational experience that immerses students in liberal-learning, secondary education, and physics major courses in an environment that combines critical thinking with active practice. Some highlights are:

- **Liberal learning and introductory physics** – The physics department offers five liberal learning courses that span general physics, astronomy, and geoscience; these courses typically serve over 800 students per year. All courses give students in-depth laboratory experience. The department also offers multiples sections of introductory physics, serving an additional 800 students per year

from the departments of engineering, chemistry, biology, and mathematics, computer science, as well as students from all other disciplines.

- **Secondary education** – The physics department is extremely proud to carry on the deep institutional mission of teacher education. The department offers a degree path leading to secondary education certification, and has recently been awarded a \$1.2 million Noyce Award from the National Science Foundation for the enhancement of this mission. The TCNJ physics department consistently ranks in the **top 1% nationally** in the number of physics secondary education graduates. During 2013-2016 TCNJ Physics ranked **2nd nationally** by number of physics teacher certifications among all U.S. college and university physics departments. This productivity has resulted in major recognition, including awards announced in *The Chronicle of Higher Education* (<http://www.phystec.org/the5plus/>).
- **Physics major education** – The physics department has designed a curriculum that offers physics students specializations in astrophysics, biomedical physics, computational physics, geophysics, and materials physics. As a result, the department typically enrolls 80-100 physics majors, and is recognized annually by the American Institute of Physics as one of the top producers of physics majors in the United States. ***In fact, the most recent report of the American Institute of Physics ranks TCNJ's physics department in the top 1% nationally for physics graduates among 496 non-PhD granting institutions in the U.S., and in the top 5% nationally among all 751 PhD and non-PhD granting institutions in U.S.***
- **Site selection for Conference on Women in Undergraduate Physics (CUWiP)**- The physics department has been selected by the American Physical Society (APS) as a regional host site for the 2019 CUWiP (<http://www.aps.org/programs/women/workshops/cuwip.cfm>). These conferences help undergraduate women continue in physics by providing them with the opportunity to experience a professional conference, information about graduate school and professions in physics, and access to other women in physics of all ages with whom they can share experiences, advice, and ideas. The effort to host CUWiP was led by TCNJ physics faculty member Angela Capece, and involved the entire TCNJ physics community of faculty, students, and staff. The resulting proposal will bring several hundred young women to TCNJ for a 3 day event of workshops, presentations, and discussions, all designed to encourage women to pursue a career in physics. Local industrial and high-school institutions will be partners in this conference, and our own outstanding community of physics students will be active partners in the planning and operation of the conference. TCNJ is proud to host this conference, which is simultaneously hosted in other regions by institutions such as the University of California Santa Barbara and The College of William and Mary.

One outcome resulting from our singular pursuit of teaching excellence is reflected in the post-baccalaureate trajectory of TCNJ physics graduates. Over the past five years the department has graduated 130 majors, of which 39% have gone on to graduate or professional schools, 15% have become high school physics teachers, and the rest have gone on to work in the private sector or the government. Our graduates are attending prestigious institutions such as UC-Davis, Yale, and the U-Penn. In fact, a National Science Foundation study ranking the undergraduate institutions attended by 2015-16 PhD recipients in the physical sciences placed TCNJ just behind Harvey Mudd and Carleton College, equal to Stanford, and above Princeton, Brown, and Yale in terms of number of PhD recipients. The broad background of TCNJ physics graduates has allowed them to conduct their graduate/professional studies in diverse fields such as physics, astrophysics, biomedical physics, biophysics, geosciences, intellectual property law, MD, MD/PhD, and robotics. Our graduates that have gone directly into the private sector have been hired by companies such as Lockheed Martin, Edmund Optics, Thor Labs, SRI International, ING Financial, Towers Watson Global Professional Consulting.

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## Academic Excellence

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The last few years have seen a dramatic increase in scholarly activity within the TCNJ Department of Physics. This is measured in peer-reviewed publications, presentations at national and international conferences, and externally funded grants. Perhaps most important is that this level of activity has been achieved with TCNJ undergraduate physics majors as central participants and full collaborators. Examples of academic excellence include:

**A) Peer-reviewed publications – (78 total since 2011; 20 of these had student coauthors)** Listed below is a sample of the national and international peer-reviewed journals that have published research by TCNJ physics faculty members and students since 2011.

- Angela Capece – *Applied Physics Letters* (2016), *Journal of Nuclear Materials* (2015), *Journal of Applied Physics* (2016)
- Danielle Dalafave – *International Journal of Computational Bioinformatics and In Silico Modeling* (2016), *Bioinformatics and Biology Insights* (2012)
- Nathan Magee – *Science Scope* (2015), *Atmospheric Chemistry and Physics* (2014), *Bulletin of the American Meteorological Society* (2014), *Atmospheric and Solar-Terrestrial Physics* (2012), *Atmospheric and Oceanic Technology* (2011)
- David McGee – *Applied Physics Letters* (2015, 2013), *ACS Nano* (2012)
- Tuan Nguyen – *Applied Network Science* (2017), *Journal of Neuroscience* (2014)
- Romulo Ochoa – *Physics Teacher* (2015, 2014, 2011)
- AJ Richards – *Physics Education Research Proceedings* (2016, 2013), *Physics Education Research* (2013), *Physics Teacher* (2018).
- Thulsi Wickramasinghe – *Astrophysics and Space Science* (2105), *Journal of Physics A* (2016), *American Society of Mechanical Engineers (IMECE)* 2014
- Paul Wiita – *Astrophysical Journal* (2016, 2014, 2013), *Astronomy and Astrophysics* (2015, 2012), *Astronomical Journal* (2013, 2012, 2011), *Monthly Notices Royal Astronomical Society* (2017, 2016, 2015, 2014, 2013, 2012, 2011)

**B) Professional conference presentations** – Nearly all members of the physics department attend one or more professional conferences per year, with a significant portion presenting research results, and co-authoring these presentations with TCNJ physics undergraduates. Since 2011, TCNJ physics faculty members have made **107 presentations at professional conferences; 50 of these were with student coauthors**. Some examples are:

- Angela Capece – IEEE International Conference on Plasma Science, Atlantic City, NJ, May 2017.
- Danielle S. Dalafave – Bulletin of the American Physical Society, APS March Meeting, Baltimore, MD, March 2016.
- Nathan Magee – Physics Teacher Education Coalition (PhysTEC) 2017 Conference, Atlanta, GA, February 2017.
- David McGee – Conference on Lasers and Electro-Optics, Munich, Germany, June 2017
- Tuan Nguyen- Biophysical Society Annual Meeting, Los Angeles, CA, March 2016.
- R. Ochoa – AAPT 2018 Winter Meeting, San Diego, CA, January, 2018
- A.J. Richards- AAPT 2017 Summer Meeting, Cincinnati, OH, July 2017.

- Paul Wiita – International Conference on Black Hole Accretion and Jets, Kathmandu, Nepal, October 2016.
- Thulsi Wickramasinghe - Sant Cugat Forum on Astrophysics, Barcelona, Spain, April 2014

**C) External funding** – The TCNJ physics department has an outstanding record of peer-reviewed, externally funded grants. This is additionally impressive in light of the 10-15% proposal success rate typical of federal funding agencies. ***From January 2017-February 2018, the TCNJ physics department submitted 5 proposals to federal and private funding agencies requesting \$1.14 million in external funding.*** These are currently under review.

Since 2011, the department ***has been awarded over \$2 million in external funding*** for the following proposals:

- Angela Capece – Department of Energy, Visiting Faculty Program, “*Extraction and Characterization of Plasma-Synthesized Nanoparticles,*” 2016, \$13,000.
- Nathan Magee (TCNJ PI), M. Kavic, M. Benoit, and P. Wiita – NASA “*Fertilizing ROSES through the STEM: Interdisciplinary Modules as Pre-Service Research Experiences for Secondary STEM Educators (IMPRESS-Ed),*” 2011-2014, \$161,896.; Nathan Magee (PI), A.J. Richards, P. Wiita, and L. Madden – “*NSF-Noyce: Preparing Highly Qualified Physics Teachers,*” National Science Foundation-EHR-DUE, 2016-2021, \$1,200,000. Nathan Magee (PI), “RUI: Nanoscale Ice Roughness,” National Science Foundation-GEO-AGS, 2015-2018, \$198,000.
- David McGee (PI) – National Science Foundation, “*Orientational relaxation of chromophore order in nonlinear optical block copolymers,*” 2011-2013, \$288,000; David McGee (PI) – Department of Energy, “*Optical and electro-optic modulation of biomimetically functionalized nanocarbon materials,*” 2013-2016, \$90,000 to TCNJ (\$898,000 total); David McGee (PI) – German Academic Exchange Service, 2014, \$9,000.
- Tuan Nguyen (PI) – Army Research Office, “*To develop an in vitro model to study the effects of mild traumatic brain injury on functional connectivity in neuronal networks,*” 2014, \$50,000.
- A.J. Richards (Co-PI), N. Magee (PI), L. Madden (Co-PI), and Paul Wiita (Co-PI) – National Science Foundation, “*Preparing Highly Qualified Physics Teachers,*” 2016, \$1,200,000.
- Paul Wiita – NASA (Kepler and K2 GI programs), “*Understanding Blazar Variability through Kepler,*” and four similar grants: 2011-2017, \$32,823 to TCNJ (\$209,000 total); Paul Wiita (PI) – NASA (Fermi GI program), “*Optical Time Variability of OJ 287, 3C 446 and Other Fermi Blazars,*” 2015-2016, \$4,000 to TCNJ (\$60,000 total).

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## Student Involvement

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A hallmark of the TCNJ physics program is the deep level of student engagement beyond the conventional classroom boundaries. On any given day, TCNJ physics majors can be found collaborating side-by-side with a faculty member in a research lab, directing a public observatory showing, or working as a learning assistant in an introductory laboratory class. Student involvement in the scholarly life of the department is primarily found in the independent research experience. Here, students spend 6-12 hours per week collaborating directly with a faculty member on a mentored research project.

*This culture of student engagement is deeply ingrained in the department, and in any given semester nearly all faculty members involve anywhere from 1-5 students in such individualized projects; from fall 2012 through spring 2018, over 200 such projects were mentored by physics department faculty members.*

Students are also encouraged to support the educational mission of the department. The department currently manages multimillion-dollar investments in a scanning electron microscope, atomic force microscope, and astronomical observatory. Each of these facilities is staffed with physics majors who train both faculty members and other students as well as demonstrate these facilities to potential TCNJ students and their parents. Typically ten physics majors per year participate as department aides, providing them with an outstanding opportunity to get to know faculty at a personal level, while also gaining valuable skills for postgraduate life.

Another dimension of student involvement centers around the department's two disciplinary student organizations: the Physics Club and the Astronomy Club.

- The Physics Club is integral to the life of the department in ways that cannot be measured by enrollments, grades, or postgraduate starting salaries. The TCNJ Physics Club is officially a chapter of the national Society of Physics Students (SPS) organization, and its central role is to promote the value of a physics education and to provide a welcoming and supportive community for all students, whether they are a physics major or are taking a liberal learning course in the department. Among other activities, Physics Club members tutor students in all levels of physics classes, and organize “physics demonstration days” at local schools. Physics club members are also essential to the many departmental open house events. Each of the six open house events per year (e.g., Accepted Students Day, Lions Day) involve 4-6 physics majors who are not just observers, but who participate equally with faculty members. Indeed, the physics majors are the focus of these events. As they lead tours, answer questions, and dine with prospective students, the majors paint a picture of a welcoming and inclusive department that resonates with prospective students and their parents. Over the years, the TCNJ Physics Club has been recognized by the national Society of Physics Students. The last two years our chapter has been selected as a Distinguished SPS Chapter at the national level.
- The Astronomy Club plays a similarly integral role in the Physics Department. Members of the Astronomy Club also engage in the department's open house events alongside their peers as described above. In addition, the TCNJ Astronomy Club hosts at least one “star party” every semester where these portable telescopes are set-up outside on Quimby's Prairie. Usually 100-200 students, faculty, staff, and friends come to observe the Moon, planets, and star clusters.