2024-25 NEWSLETTER

PHYSICS & ASTRONOMY

MACALESTER

NGC 6946 - IMAGE PRODUCED BY THE ROBERT L. MUTEL TELESCOPE IMAGING SYSTEMS

GREETINGS FROM THE CHAIR, JIM DOYLE

Hello Mac Physics and Astronomy Grads!

Welcome to the Macalester College Department of Physics and Astronomy inaugural annual newsletter! We have considered doing this for some time, and are finally getting around to it. We hope to make this an on-going tradition to help stay connected with all of you.

After a nearly 20-year hiatus, I assumed the department chair again in 2023. It is sometimes thought that the chair is a position of prestige, but in reality, it's just to make sure that the trains run on time! Typically, we rotate 6-year terms, and my number was up, though I plan on doing only 3 years this time around.

As the chaos of the pandemic begins to fade into a distant memory (and many thanks to John Cannon for exemplary leadership of the department through those times!), I'm happy to report that the department continues to thrive. Our major numbers remain strong overall, and our graduates continue to go out into the world and do great things. There have been a number of highlights over the past few years. In 2022 for the first time we offered an algebra-trig (no calculus) introductory physics sequence. By all accounts the course is a success, and we are very grateful to Visiting Professor Saki Khan for spearheading the effort, along with Brian Adams for the labs.

(chair cont.) Last summer we hired Kate Anders as our new department coordinator (shared with Geology). Kate is doing a fantastic job for us, including leading the effort on this newsletter! We are also privileged to have Distinguished Visiting Professor Jay Gallagher teaching with us. Jay retired from the Astronomy Department at University of Wisconsin Madison and has relocated to the Twin Cities for family reasons, and has co-teaching courses and taking on research students. And certainly, one of the most exciting developments in the department has been the MACRO work that John Cannon is leading (see John's blurb below). I attended the summer meeting of the AAS in Madison last June and was deeply impressed by the quantity and quality of the MACRO work.

In future iterations of the newsletter we would like to include contributions from any of you who would like to share recent news in your life with the department and your fellow alums. In November 2025 we will send you a request to contribute to the 2026 newsletter – look for that next November! In the meantime if you would like to share anything with the faculty and staff now feel free to send me (doyle@macalester.edu) or Kate Anders (kanders@macalester.edu) a few sentences and we will circulate your news in the department.

Best wishes to everyone for the New Year!

>>> PROF. JAMES HEYMAN

I've been teaching and doing physics at Macalester for more than 30 years and I continue to appreciate the wonderful students and supportive environment here! In my lab I continue to use ultrafast optical techniques to study novel materials for solar cells. In 2023 Rohan Lichtenberg (Mac '25) and Max Zinman (Mac '24) worked with me to show that ultrafast THz spectroscopy could measure the carrier mobility and composition of perovskite semiconductors, and Issac Kisker (Mac '25) wrote software to analyze our results. Last summer I worked with Addison Dau (Mac '25) and Ethan Dale (Mac '27) to study how perovskite semiconductors break down and degrade under UV light exposure. These materials could power the next generation of solar cells if their reliability and lifetime can be improved. We contributed to a study of the inorganic semiconductor GaAsNBi that was published this year (*https://doi.org/10.1063/5.0187750*). In the fall semester I got to teach some of my favorite courses, Modern Physics and Condensed Matter Physics. This spring it will be more favorites: Statistical Mechanics and – back after a long hiatus – Optics.

PROF. JOHN CANNON

As the Director of the MACRO Consortium, Professor John M. Cannon oversees the operation of the Robert L. Mutel Telescope (RLMT - a robotic optical telescope located in southern Arizona). 2024 was a banner year for MACRO. A new spectroscopic capability was introduced and the inaugural MACRO Summer Program (which showcased RLMT and Very Large Array observations of an exotic binary star system) was a resounding success. Cannon organized a special session about MACRO at the 244th American Astronomical Society meeting (which was highlighted by twenty research posters, most led by students as the first author) and was the P.I. on an NSF grant proposal for MACRO. In the spring semester of 2025, Cannon will teach a novel inter-institutional topics course in which RLMT data will be examined by more than 40 students from across the MACRO Consortium. In 2024, Cannon published four scholarly articles with Macalester student co-authors and was awarded radio telescope observing time as the P.I. on the Very Large Array, the Green Bank Telescope 100m, and MeerKAT.

Spiral Galaxy M33 - Image produced by the Robert L. Mutel Telescope Imaging Systems

PROF. JAY GALLAGHER

Visiting Professor Jay Gallagher's extragalactic astronomy is benefitting from contributions by 3 Mac student assistants. Lila Schisgard and Will St. John are part of an international collaboration based at Chalmers University in Sweden studying galaxies whose extremely luminous central nuclei are hidden behind huge amounts of dusty molecular gas. Lila's and Will's quantitative mapping of light absorption by dusty gas in images of target galaxies obtained by the Hubble Space Telescope provides critical information on the processes that lead to extreme central gas concentrations in the rare class of CON ("compact obscured nucleus") galaxies. Lila advanced the mapping process by building software to allow repeatable determinations of dust absorption levels. Will is also exploring possible evolutionary paths by comparing fundamental properties of CON galaxies with those of other galaxies with extremely luminous nuclei, a process that suggests young stars may be important power sources in CONs. These investigations are part of the CON-QUEST project that seeks to understand conditions where the nuclei of galaxies that contain giant central black holes experience rapid evolution fueled by massive inflows of interstellar gas.

NGC 891 - Image produced by the Robert L. Mutel Telescope Imaging Systems.

Caeden Miller is contributing to a project led from the University of Potsdam in Germany that uses newly obtained Chandra x-ray observatory data to search for massive stars with black hole companions in the nearby galaxy NGC 3109. Caeden's task was to identify massive stars in NGC 3109, a low mass galaxy located at a distance of about 4 million light years. Using images obtained with the Hubble Space Telescope, Caeden measured the brightness and colors—an indicator of stellar temperature—for all detectable stars with masses greater than about 15 times the mass of the Sun. The results of their study will be compared with locations of x-ray sources to identify which stars are powerful x-ray sources that are likely to contain black holes. The goal of this research is to contribute to our understanding of the conditions leading to the production of black holes from the evolution of massive stars in cosmic environments that are deficient in chemical elements heavier than hydrogen and helium.

PROF. JIM DOYLE

This past year has been good, and as always, I am grateful for the talented and engaged students I get to work with at Mac! As usual I am spread too thin over several projects. Recently I have been focusing more on computational research, and, pursuing an interest going back to my undergrad days, I am working more and more on biophysics and physics/biology adjacent topics. Last year Sylvia Greene (Mac '24) and I worked on a simulation of bio-polymer formation on surfaces, processes that are believed to be of potential importance in origin-of-life scenarios. Sylvia wrote a beautiful honors thesis based on her work and is presenting a poster at the Biophysical Society Meeting in February. Uditi Chandreshekar (Mac' 24) likewise wrote a wonderful honors thesis on solving the Hodgkin-Huxley equation, used to model neuron action potentials. I will be presenting this work as a poster at the BPS meeting as well. I continue to collaborate with Mike Anderson in Macalester Biology on simulations of seed dispersal of invasive plants, building on the work of Zoe Yandell (Mac '24) and continued last summer by Miri Leonard (Mac '26). Finally, just for fun last summer I also worked with a talented Japanese-English major Rachel Kelly ('Mac 25) on sustainable design aspects of traditional Japanese architecture! Next summer I plan to spend some time writing up a couple of finished (or nearly finished!) past projects. And hopefully spend as much time as I can hiking out in Colorado!

EXPERT ADVICE

Dave Bailey is a shared talent for the sciences in Olin-Rice, but officially is part of the Physics team. He invents, builds, and improves on all manner of things in the Ken Moffett Machine Shop.

PROF. ANNA WILLIAMS

The past 1+ years were filled with many new experiences for me, which included teaching new courses, working with data from a new (to me!) telescope, and initiating a new research project in compact star systems. In fall 2023, I taught my first ever First Year Course, The Solar System and Beyond.This course included a lab component where students used optical light curves to estimate the shapes of asteroids and spectra to understand why the ice giants (Uranus and Neptune) look blueish green using spectra. This was all done with observations taken with our very own optical Robert L. Mutel Telescope (RLMT). The following semester, six majors, Prof. Cannon, and I really got to know the RLMT during my first foray into teaching PHYS 440–Observational Astronomy.Students flexed the power of the RLMT through the diverse array of astrophysical objects they chose to observe: variable stars, exoplanet transits, star cluster surface brightness, and supernovas. Joining forces with the other members of the MACRO consortium, the Macalester students from PHYS 440 and I presented posters of our results during a special session at the 244th American Astronomical Society meeting held in Madison, WI this past June. I spent the remainder of summer 2024 venturing into the field of magnetic cataclysmic variables (MCV)–a big change from the extragalactic magnetic fields I studied in the past. Building off of the success of the combined RLMT and Very Large Array (VLA) radio observations of the MCV system ST LMi that were used for the first ever MACRO Summer Program, I submitted multiple proposals for a new monitoring project to study these exotic compact star systems using both optical and radio observatories. I was awarded time with the VLA this spring, and am excited to explore these new observations in 2025!

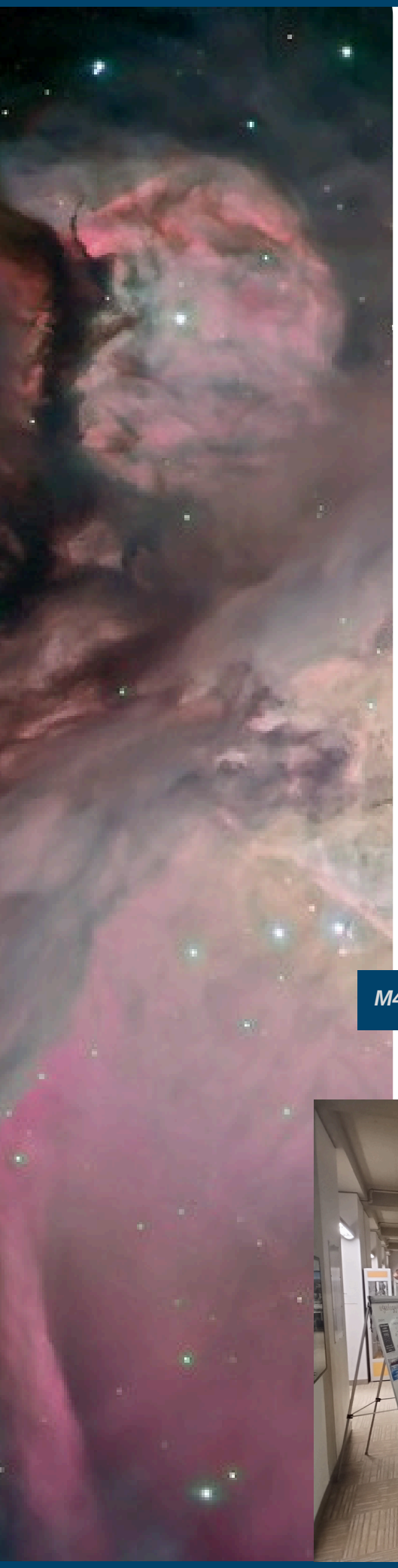
BRIAN ADAMS

In addition to his usual work as lab supervisor and observatory manager, over the past several years Brian has been engaged in several exciting new projects within the department. He worked with Saki Khan in developing the laboratory component of our new algebra-based Introductory Physics course sequence, which is targeted at life sciences majors (such as Biology, Biochemistry and Neuroscience). Brian is also thrilled to have been involved with the work of the MACRO Consortium, supporting and working with John Cannon, Anna Williams, our amazing students, and other consortium members to bring the Robert L. Mutel Telescope online and make this powerful new tool available for exciting new research projects (see John and Anna's blurbs here for a full description of this work). He really has appreciated this opportunity to once again dip his toes into astronomical research, doing photometry of minor planets and constructing light curves of these objects. The results of this work were presented, along with the results of students and colleagues at the special session of the AAS summer meeting in Madison in 2024. Looking ahead to 2025 and beyond, he is very much looking forward to continuing to support our students, John and Anna, and the MACRO Consortium in any way that he can.

The Robert L. Mutel Telescope (RLMT) and the constellation Orion, Elgin, Arizona

HELLO FROM THE OFFICE

Hi, I'm Kate Anders. As the new Department Coordinator, I'm busy getting to know faculty, staff, and learning the ins and outs of the first floor of OLRI. I'm slowly getting to know current students and hope for the chance to meet some of you. I'd love to be able to pass along your updates, and know the faculty would be thrilled to hear from you. Email me at kanders@macalester.edu, or stop by if you are near campus!



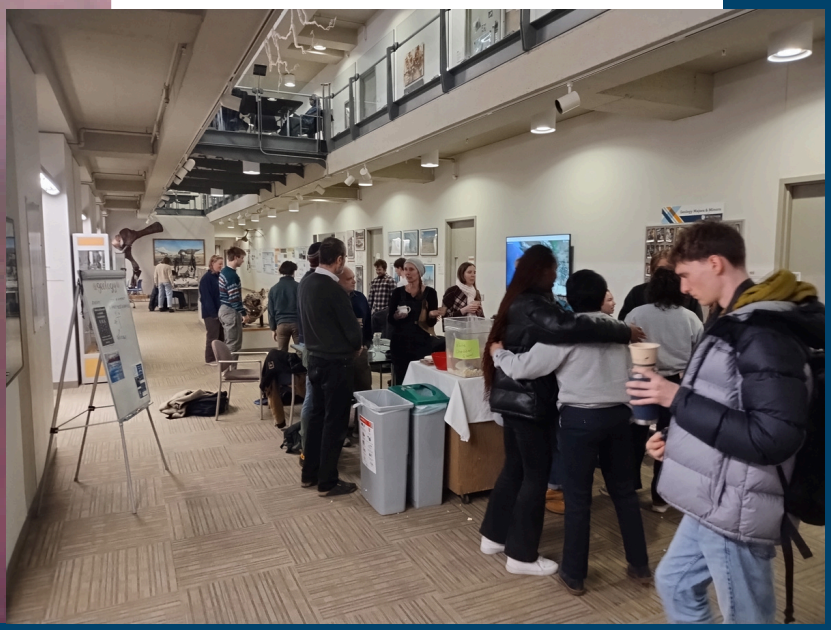
>>> PROF. SAKI KHAN

I joined the Macalester College Physics and Astronomy Department as a Visiting Assistant Professor in Fall 2021. Over the past few years, I have had the privilege of teaching a variety of courses and working with exceptionally talented students. One of the highlights of my time here has been introducing Introductory Physics, a course specifically designed for life science majors. Unlike traditional, diluted versions of engineering physics, this course emphasizes the principles of physics most relevant to biological systems. Topics include the aerodynamics of bird flight, the electric potential of the cardiovascular system, and the capacitance and resistance of the nervous system. A particularly rewarding moment was when a student enthusiastically remarked, "Turning the axon into a circuit blew my mind."

My research focuses on the construction of minimal yet realistic Grand Unified Theory (GUT) models, with an emphasis on exploring their phenomenological and cosmological implications. This includes studying nucleon decay, fermion (especially neutrino) masses and mixings, and identifying viable dark matter candidates. I am proud to share the extraordinary achievements of my students during our summer research program. In just ten weeks, Ross Ferguson (Mac'22) and Seth Buesing (Mac'23) developed a novel grand unified theory of trinification, while Xiaochuan (Chloe) Zheng (Mac'22) utilized computational tools such as FeynRules and micrOMEGA to perform numerical calculations for a dark matter model.

Recently, I have started exploring applications of data science in high-energy physics, with the aim of initiating a collaborative project on the use of machine learning techniques in particle physics. The Macalester community continues to inspire me with its curiosity and commitment to interdisciplinary learning. I look forward to building on these experiences and exploring the universe together!

M42 - Image produced by the Robert L. Mutel Telescope Imaging Systems.



TEA TIME

The Physics & Astronomy department continues the tradition of co-hosting a weekly tea with the Geology department. Before the senior seminar on Wednesday afternoons students, faculty, staff, and guest speakers share treats and conversation.

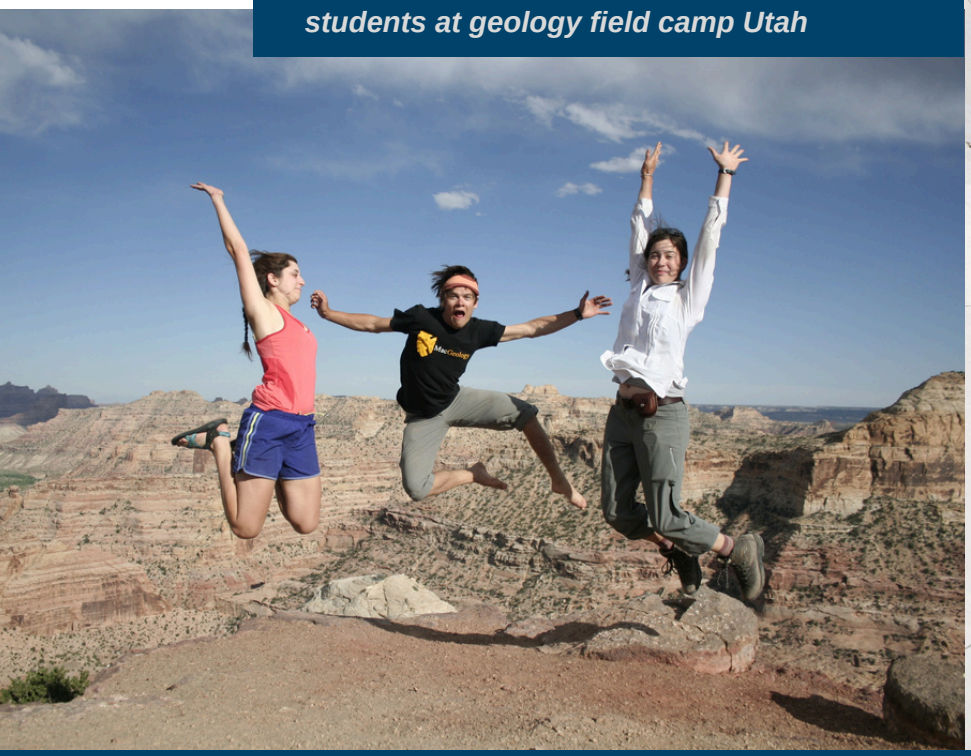
REMEMBERING CLARA THOMANN

The Department of Physics and Astronomy and the Department of Geology at Macalester College are heartbroken by the tragic and sudden loss of Clara Thomann (class of 2013) in December 2024. Department faculty and staff remember her as a warm and caring person and an exceptional student. Clara could have followed any path she wanted after graduating, but characteristically she chose to share her gifts with young people as an inspiring and dedicated teacher.

A partial list of Clara's many impressive accomplishments at Macalester include: one of the original founders of the Physics and Astronomy Club; a dedicated member of the student-run GeoClub; work as a preceptor for a first year course on astrobiology; TA for introductory Geology courses; research experiences with Macalester faculty in astronomy and geophysics; a semester-long research experience in Chile in the prestigious "Research Experiences for Undergraduates" (REU) program at the Cerro-Tololo Inter-American Observatory; summer research in the Cornell astronomy REU program; and geology field camp in Utah.

Clara was showcased in multiple stories on the Macalester website about her experiences in astronomy and geology, and she was the author of an article in the inaugural volume of the Macalester Journal of Physics and Astronomy. Clara was a wonderful and immensely accomplished person who loved to learn, to explore, and to laugh. The world is not as bright without her.

To honor and remember Clara, the Department of Physics and Astronomy will give the Clara Thomann Outstanding Student Citizen Award to a graduating senior.



Clara at the National Radio Astronomy Observatory's Very Large Array (located near Socorro, New Mexico) and with fellow students at geology field camp Utah