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Planetary Nebulae: A Universal Toolbox in the Era of Precision Astrophysics

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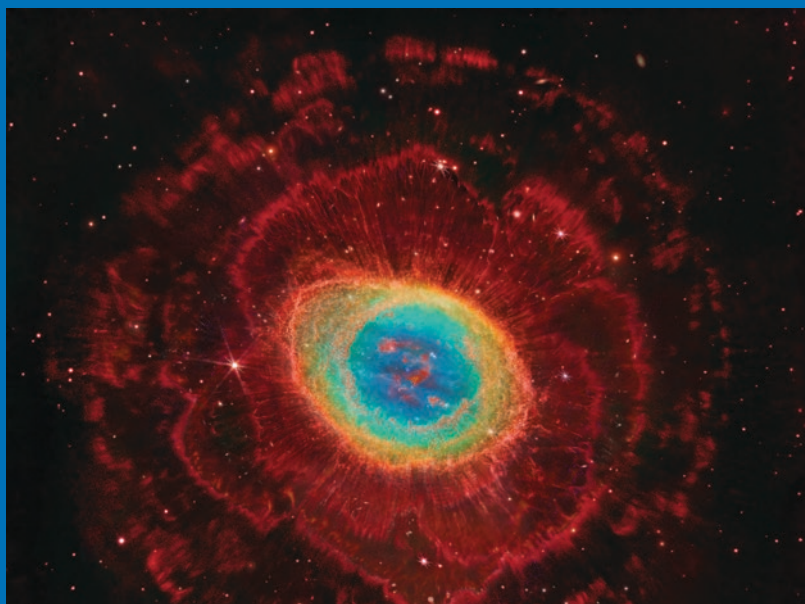
Orsola De Marco
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PLANETARY NEBULAE: A UNIVERSAL TOOLBOX
IN THE ERA OF PRECISION ASTROPHYSICS

IAU SYMPOSIUM 384

COVER ILLUSTRATION:

The planetary nebula M57, also known as the Ring Nebula. Image from multiple sources, Hubble Space Telescope (He II, [OIII], [NII]), the James Webb Space Telescope (3.3 micron), the Large Binocular Telescope (2.1 microns), the Subaru Telescope (H alpha)'' - Robert Gendler, John Bozeman, NASA, ESA, and C.R. O'Dell (Vanderbilt University).

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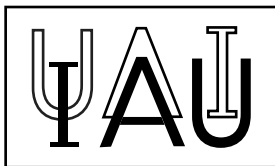
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PLANETARY NEBULAE: A UNIVERSAL TOOLBOX IN THE ERA OF PRECISION ASTROPHYSICS

PROCEEDINGS OF THE 384th SYMPOSIUM OF
THE INTERNATIONAL ASTRONOMICAL UNION
KRAKOW, POLAND
4–8 SEPTEMBER 2023

Edited by

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Preface

In this volume we present the proceedings of IAU Symposium 384: Planetary Nebulae: a Universal Toolbox in the Era of Precision Astrophysics, which was held in city of Krakow, Poland, from the 4th to the 8th September 2023, in the Collegium Novum of the historical Jagiellonian University, where Nicolaus Copernicus studied mathematical astronomy in the 1490's. The symposium was held on the 550th anniversary of Copernicus' birth. The field of astronomy has evolved since his days. Planetary nebulae were only discovered after the invention of the telescope in the 17th century, and were thus not known to Copernicus. We would like to think that had he known them he would have appreciated them for their stunning beauty, and for their significance as the embodiment of our Sun's future.

Planetary nebulae are the ejecta of dying, Sun-like stars, in the mass range 1–8 $M_{\odot}$. Their evanescent beauty seems to celebrate the life of the star that produced it! Lawrence Hugh Aller (1913–2003)[†] once called them “*The wreaths placed by Nature around dying stars*”[‡]. Over 3000 planetary nebulae are now known in the Milky Way galaxy, and many more in other galaxies.

Research on planetary nebulae covers a diverse range of topics, linking to many areas in modern astrophysics. The nebula can be thought of as a star reflecting on its past[§]: it is a unique tracer of the final stages of stellar evolution. Binary interactions are a major focus of these studies, involving jets, common envelope interactions and transient events. The spectra of the ionised nebulae provide abundances of elements, including light elements and s-process products. This gives insight into the composition of the interstellar medium at the time when the star formed, as well as knowledge of the dredge-up processes that bring to the stellar surface the elements produced deep in the stellar interior. The chemistry occurring in the nebulae is another area of intense research, involving primary production (and destruction) of complex molecules such as fullerenes and PAHs, and solid particles such as those that we find in pre-solar grains in the Solar System. Planetary nebulae are detectable to distances as far as the Coma cluster: they are the brightest phase of the evolution of low- and intermediate-mass star and more than 10% of the luminosity can come out in a single emission line. They are therefore used to study stellar populations in galaxies, including abundance gradients, galaxy dynamics and dark matter. They are also a critical rung of the extragalactic distance scale and a likely excellent tool to help resolve the current Hubble Constant tension. Finally, planetary nebulae are used effectively to engage the public and excite and educate students and teachers, and this topic was also explored during the symposium: a highlight of the meeting was an invited talk by Arianna Cortesi, on astronomical outreach and education in marginalised, indigenous communities in Brazil. The eye-opening talk showed how astronomy can be a tool for social development.

This was the 11th IAU-sponsored planetary nebula symposium, a series that started in 1967. They have been held in 10 different countries and on all continents except South America and Antarctica. The community is as diverse as the topic itself. The current symposium attracted 104 participants from 26 different countries. One third of the participants were female. At the very first of the IAU Symposia in 1967, female participants accounted for only 10% of the group, suggesting we are halfway on the journey to gender parity. Half the invited talks and Invited reviews were by female speakers.

[†] <https://baas.aas.org/pub/lawrence-hugh-aller-1913-2003/release/1>

[‡] Kwitter & Henry, 2022, PASP, 134,02.2001

[§] Menzies & Whitelock, 1988, MNRAS, 233, 697

Table 1. IAU Symposia on planetary nebulae, 1967–2023

IAUS 384	09/2023	Planetary Nebulae: a Universal Toolbox in the Era of Precision Astrophysics	Krakow, Poland
IAUS 323	10/2016	Planetary Nebulae: Multi-Wavelength Probes of Stellar and Galactic Evolution	Beijing, China
IAUS 283	07/2011	Planetary Nebulae: an Eye to the Future	Puerto de la Cruz, Tenerife, Spain
IAUS 234	04/2006	Planetary Nebulae in our Galaxy and Beyond	Waikoloa Beach, Hawai'i, USA
IAUS 209	11/2001	Planetary Nebulae: their Evolution and Role in the Universe	Canberra, Australia
IAUS 180	08/1996	Planetary Nebulae	Groningen, the Netherlands
IAUS 155	07/1992	Planetary Nebulae	Innsbruck, Austria
IAUS 131	10/1987	Planetary Nebulae	Mexico City, Mexico
IAUS 103	08/1982	Planetary Nebulae	London, UK
IAUS 76	06/1977	Planetary Nebulae	Ithaca, New York, USA
IAUS 34	09/1967	Planetary Nebulae	Tatranská Lomnica, Tatras Mountains, Slovakia

Because of the 550th anniversary of Copernicus’ birth, Polish television interviewed participants at the Symposium. The city of Krakow dates to the 7th century; the Old Town was one of two cities on the very first UNESCO World Heritage list. Many of the old buildings and churches in the city centre still survive. The Jewish quarter retains sacred architecture and a living Jewish culture which is unparalleled in Poland. The Yiddish culture was celebrated with a concert at the conference dinner.

The Jagiellonian University, its staff and students supported the IAU Symposium brilliantly. The organisers gratefully acknowledge financial support from the IAU and from the Polish Ministry of Education and Science under the program Excellent Science II. The meeting was organised by IAU commission H3, Planetary Nebulae. It was coordinated by IAU Division H and endorsed by Divisions C, G and J. IAU funding was used to support students and early-career scientists. 20 people from 15 countries received IAU travel grants.

A prize was awarded for the best poster at the meeting: we are very happy to announce that this was won by Silvia Tosi from Rome Observatory, Italy.

The Organizing Committee

Scientific

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The Local Organizing Committee operated under the auspices of the Nicolaus Copernicus Astronomical Center of the Polish Academy of Sciences (CAMK PAN) and the Jagiellonian University (UJ).

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