INTERVIEW WITH **Grazyna Stasinska**

TAKING FINGERPRINTS

«Planetary nebulae help astronomers understand other objects in the Universe»

By CARMEN DEL PUERTO, IAC Editor-in-Chief

Her work does not consist in smearing fingers with special ink and pressing them on prepared pads with a view to thus identifying each of the lines on the surface of each digit. She is not searching for criminals by consulting and comparing files at police headquarters. Hers is not a police investigation. Nevertheless, the French astrophysicist Grazyna Stasinska, from Paris-Meudon Observatory (France) studies the telltale traces of the chemical elements in the spectra of, for example, planetary nebulae, which, apart from being among the most beautiful objects in the sky, are also of great use to astronomers. For this reason, Stasinska is one of the lecturers of the XVIII Winter School of the Instituto de Astrofísica de Canarias (IAC), now taking place at the Conference Centre of Puerto de la Cruz (Tenerife) and dedicated this year to «emission lines» a code, not yet fully understood, for deciphering the encrypted message of the Universe.

The central region of NGC 6720 (M57), popularly known as the Ring Nebula in the constellation Lyra.

CREDIT:

These images are taken from the IAC catalogue of planetary nebulae
The IAC Morphological Catalog of Northern Galactic Planetary Nebulae.

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Published by the Instituto de Astrofísica de Canarias

Instituto de Astrofísica de Canarias (IAC)

Most astronomers, Grazyna Stasinska among them, agree that astrophysics was born with the discovery of *spectroscopy*. From that moment on, astronomers could study the nature of stars and other objects in the Universe by analysing their spectra – that is, the visible light and other kinds of radiation that they produce. **'And they began,'** says the researcher, **'to distinguish galaxies from nebulae and to impose some kind of order on the catalogue of extended objects provided by the French astronomer Charles Messier, who had mixed all the objects together.** The first type of object – galaxies – had spectra similar to those of the stars; the second type – nebulae – showed peculiar lines in their spectra **'that could be characteristic of the chemical elements in the gases of which they were composed,'** explains Stasinska, an expert in nebulae. Astrophysics had taken its first steps.

Erroneous nomenclature

There are many species in the Universe that astronomers order, describe and classify according to some taxonomical scheme. Hence, nebulae may be of three types: *emission*, *reflection* and *absorption*. Emission nebulae are clouds of gas and dust that emit red light when heated by radiation from nearby young hot stars, an example being the Orion Nebula. Reflection nebulae (clouds that shine by light reflected from a star), for example the Pleiades Cluster, appear blue because their light is scattered by particles of dust. Absorption, or *dark*, nebulae, such as the Horsehead Nebula in Orion, are clouds of cool gas and dust visible only in silhouette against a background of more distant stars.

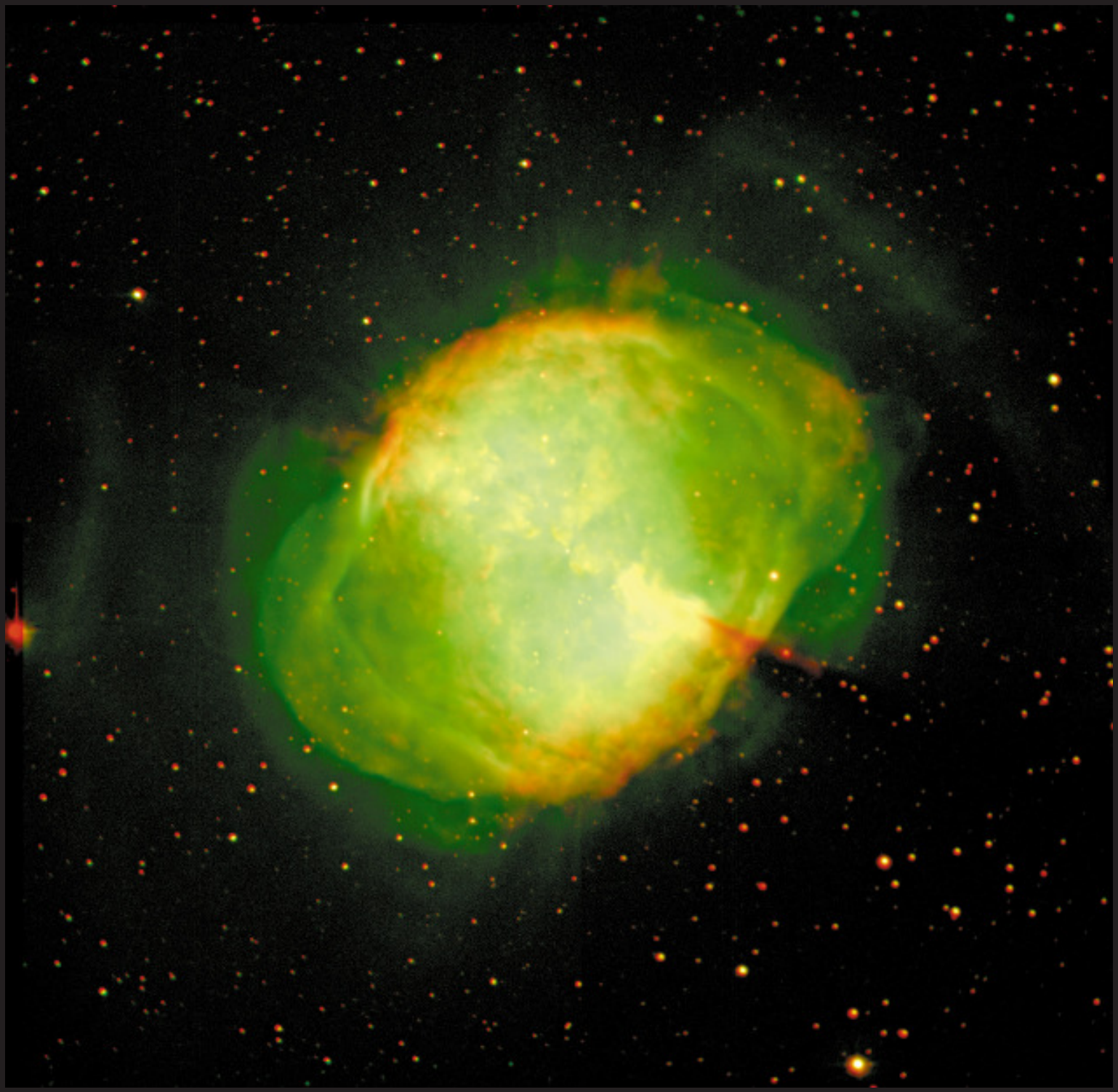
But in 1785, Messier´s contemporary, the astronomer and musician William Herschel, of German origin, published an article in which he classified a type of nebula that appeared observationally to be distinct from the others. He called them <<planetary nebulae>> because they reminded him of the greenish disc of a planet. However, not only were they certainly not planets but they were also wrongly considered to be young spherical gaseous objects in the process of condensing into newly formed stars. **'Nowadays,'** says Stasinska, **'the term planetary nebula is one of many anomalies in astronomical terminology.'** But they are no less interesting for all that and this French astronomer remains faithful to their study.

Astrophysical tools

We know that, towards the end of their lives, solar-type stars puff off their outer layers, which gradually extend and dilute, eventually blending with the interstellar medium while the stellar remnant follows its evolutionary path until converting itself into a *white dwarf* – a <<star corpse>>. Such is a planetary nebula, which, in spite of the inappropriateness of the term, defines the final stage of a star, a stage that will happen to our Sun in about 4500 million years´ time.

Planetary nebulae, apart from providing us with spectacular images, are also of great scientific interest. **'First,'** notes Stasinska, **'they are objects whose chemical composition we can measure accurately. If we measure planetary nebulae in various parts of the Galaxy, we can establish the chemical composition of those regions. There are likewise some elements that are formed inside the stars that produce planetary nebulae. In a nebula we can see the *signature* of the element's formation, which gives us a better idea of the nucleosynthesis in all those stars.'**

But planetary nebulae harbour much more information. **'For example,'** the researcher continues, **'these objects have emission lines, although very few, for which reason they are very easy to recognize at great distances; that makes it possible to discover the presence of planetary nebulae in galaxies where the stars can't be seen; if there's a planetary nebula, then there's a star from which the nebula was born. In this way we are discovering stars outside the galaxies.'** Planetary nebulae are valuable tools in astronomy. **'I like**



"LNGC 6853, the Dumbell Nebula. The death throes of a star like our Sun. Colour image taken at the 2.5 metre Isaac Newton Telescope, at Roque de los Muchachos Observatory (La Palma)."

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to work with them for that reason,' affirms Stasinska. So much so, that last year she organized, in Gdansk (Poland), the international conference *Planetary Nebulae as Astronomical Tools*.

Chemical composition

There are, without a doubt, high expectations in the astrophysical community regarding emission lines in astronomical objects, which will perhaps tell us things about the Universe that we don't yet know. These lines can serve, for example, in the detection of remote objects such as active galactic nuclei, quasars and primitive galaxies, and are fundamental for the study of star formation and the metallicity of galaxies.

Stasinska ponders her reply for a few seconds to the question of whether we have a good understanding of the chemical composition of the Universe: **`Bearing in mind that we're talking about stars and remote galaxies that we've never visited, and that we carry out our investigations by relying exclusively on photons that we receive from them, we can say yes – although, for example,'** she warns, **`we don't know the chemical composition of the Sun very well.'**

But the future is encouraging. **`We've only been working with emission lines for the past 50 or 60 years and they haven't yet yielded all their secrets. Still, the new observational techniques, especially in the infrared, will enable us to make better measurements and resolve some issues.'** The GTC (Gran Telescopio CANARIAS) and its instrumentation will open up great possibilities in this regard. **`With it we'll be able to observe very remote objects with good signal-to-noise, as well as closer objects, such as nebulae in our Galaxy,'** indicates Stasinska.

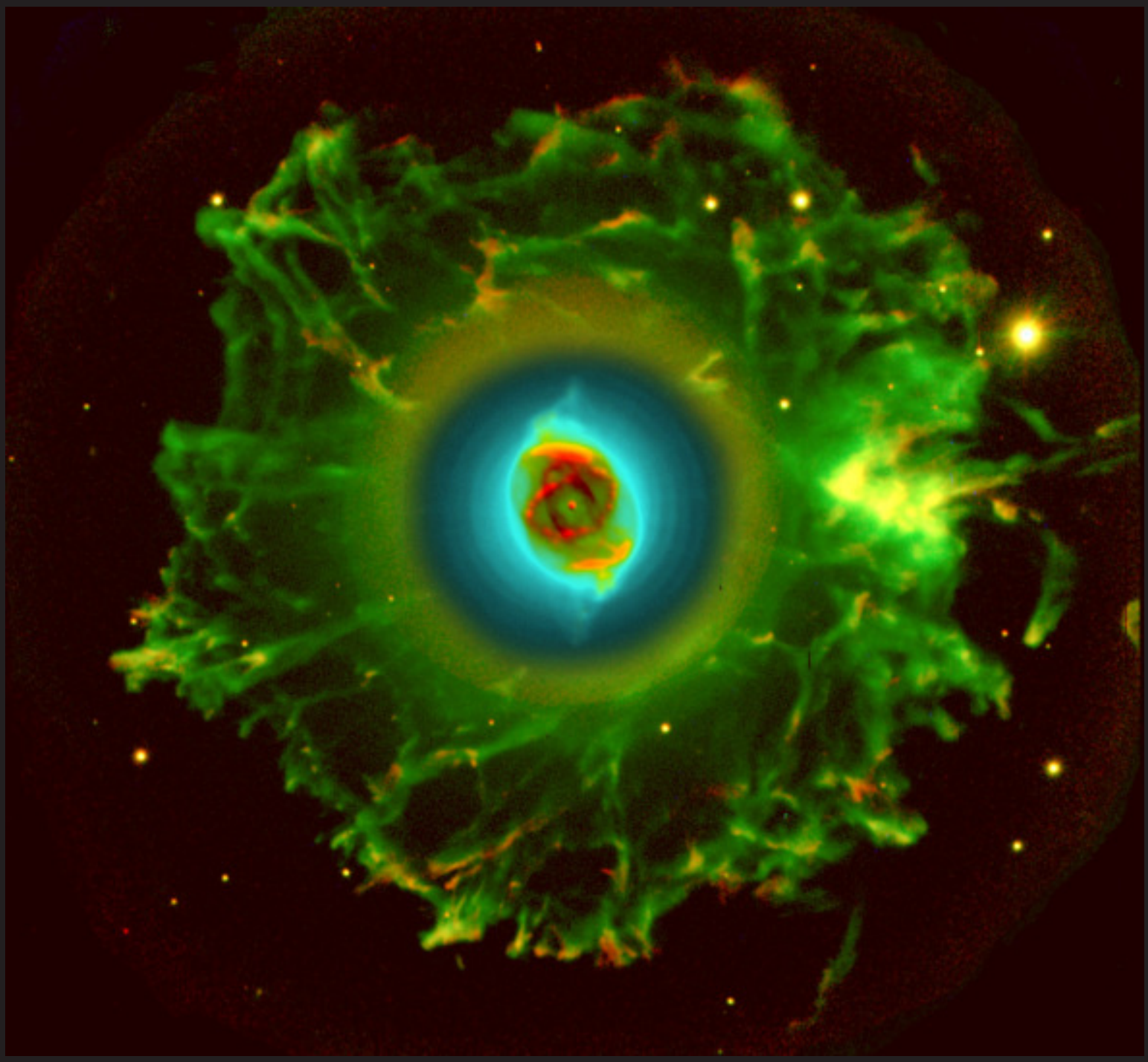
In 2001, Stasinska was at the XIII IAC Winter School on the topic *Cosmochemistry: the Crucible of the Elements* and is now repeating the experience. When asked what has changed in Astronomy during the last five years, she pauses a while before replying, **`We've a better knowledge of gamma-ray bursters, which nevertheless will continue to puzzle us for years to come. There are also many more observations of galaxies with infrared lines and this is opening up a new field that allows us to probe the chemical composition of starbursts in the infrared. And of course,'** she adds as if worried she'll forget to mention it, **`there is the whole subject of the astronomy of exoplanets, because more and more objects are being discovered. This field is developing rapidly.'**

Even though she could add many more questions, Stasinska takes note of one alone, and not the least important one at that. According to her, **`what has changed is the way of doing astronomy, with teams of people becoming large, which is necessary in order to carry out surveys such as the *Sloan Digital Survey*, which has obtained spectra of hundreds of thousands of galaxies, thus permitting a better understanding of the «nearby» Universe.**

And Pluto? Stasinska notes that she is not sufficiently expert to comment on the question. However, she remarks that, after consulting with specialists, she understands that **`there were good reasons for making the decision that was made.'**

Science policy

Unhappy with science policy in France, Stasinska blames the Government of that country for ignoring fundamental science, **`so important for a civilization,'** and for promoting



Halo of the Cat's Eye (NGC 6543).
Credit: R. Corradi (Isaac Newton Group), D. R. Gonçalves (Instituto de Astrofísica de Canarias).
The image was taken by the Nordic Optical Telescope (NOT) in the Observatorio del Roque de los Muchachos (ORM).

teams instead of nurturing these investigations. **'I think it's necessary to give more freedom to researchers and to allow them to decide what they want to investigate. Of course it's necessary to programme large projects, such as the construction of telescopes (that isn't something that can be done without planning), but around this it's essential to allow a certain degree of freedom. If we don't do that, then we're not really doing research. And that's what's happening in astronomy, but not in medicine, for example.'**

Stasinska collaborates with researchers from countries like France, Brazil, Mexico and the United States, and communicates with her colleagues in their languages. But she travels most frequently to Poland, where, as we have seen, she not only organizes conferences in the home city of the Polish astronomer Hevelius, author of another famous catalogue, but also to work at the Astronomical Centre of Torun. Her Polish origins make her feel close ties with the land of Copernicus. **'Today,'** declares Stasinska, **'astronomy in Poland has a strong theoretical base. That is because, in the past, there were no observing facilities and the main efforts of the scientists were devoted to calculations in purely mathematical or physical research.'**

Stasinska is currently heading a collaborative project between France and Poland consisting of a group of 60 scientists (30 from each country). **'We're trying to make this sort of exchange work and,'** she notes with satisfaction, **'it's going well.'** A tribute to that daring astronomer who revolutionized science by postulating that the Earth and other planets orbited a Sun that stood motionless at the centre of the Universe.

Photos of Grazyna Stasinska: Miguel Briganti (SMM/IAC)