

# 2020 NOBEL PRIZE: PHYSICS

On 6 October, the Royal Swedish Academy of Sciences announced the decision to award the Nobel Prize in Physics 2020 to Roger Penrose “for the discovery that black hole formation is a robust prediction of the general theory of relativity” and to Reinhard Genzel and Andrea Ghez “for the discovery of a supermassive compact object at the centre of our galaxy”. One half of the prize money of 10 million Swedish kronor went to Roger Penrose and the other half jointly to Reinhard Genzel and Andrea Ghez.

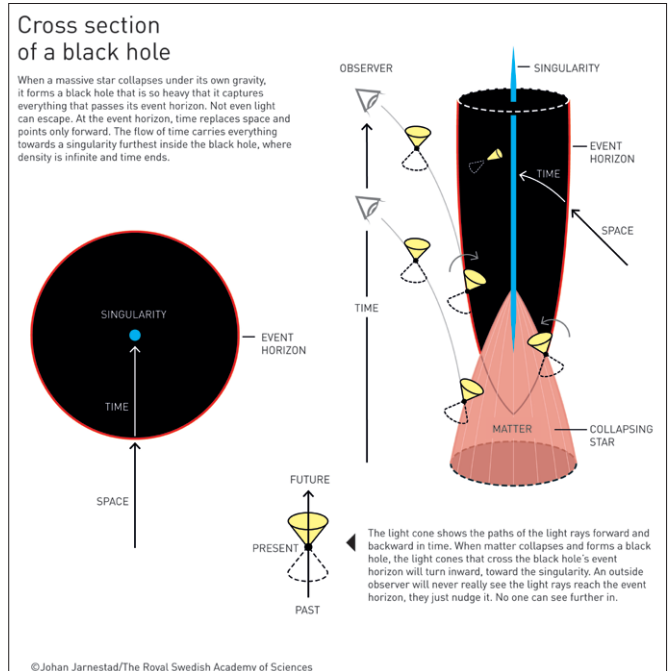
## Black holes and the Milky Way’s darkest secret

Roger Penrose (University of Oxford, United Kingdom) used ingenious mathematical methods in his proof that black holes are a direct consequence of Albert Einstein’s general theory of relativity. Einstein did not himself believe in the existence of black holes, which capture everything that enters them – nothing can escape, not even light.

In January 1965, 10 years after Einstein’s death, Roger Penrose proved that black holes really can form, and described them in detail. At their heart, black holes hide a singularity in which all the known laws of nature cease. Penrose’s groundbreaking article is still regarded as the most important contribution to the general theory of relativity since Einstein.

Reinhard Genzel (Max Planck Institute for Extraterrestrial Physics in Germany and University of California, Berkeley, USA) and Andrea Ghez (University of California, Los Angeles, USA) discovered that an invisible and extremely heavy object governs the orbits of stars at the centre of our galaxy. A supermassive black hole is the only currently known explanation.

The two scientists each lead a group of astronomers who, since the early 1990s, have focused on a region called Sagittarius A\* at the centre of our galaxy. The orbits of the brightest stars closest to the middle of the Milky Way have been mapped with increasing precision. The measurements of these two groups agree, with both finding an extremely



heavy, invisible object that pulls on the jumble of stars, causing them to rush around at dizzying speeds. Around four million solar masses are packed together in a region no larger than our solar system.

Using the world’s largest telescopes, Genzel and Ghez developed methods to see through the huge clouds of interstellar gas and dust to the centre of the Milky Way. Stretching the limits of technology, they refined new techniques to compensate for distortions caused by the Earth’s atmosphere, building unique instruments and committing themselves to long-term research. Their pioneering work has given us the most convincing evidence to date of a supermassive black hole at the centre of the Milky Way.

“The discoveries of this year’s Laureates have broken new ground in the study of compact and supermassive objects. But these exotic objects still pose many questions that beg for answers and motivate future research. Not only questions about their inner structure, but also questions about how to test our theory of gravity under the extreme conditions in the immediate vicinity of a black hole,” says David Haviland, chair of the Nobel Committee for Physics.

- <https://www.nobelprize.org/prizes/physics/2020/press-release/>  
See the popular science background at: <https://www.nobelprize.org/uploads/2020/10/popular-physicsprize2020-1.pdf>  
or the scientific background at: <https://www.nobelprize.org/uploads/2020/10/advanced-physicsprize2020.pdf>



Niklas Elmehed, Nobel Media

Roger Penrose, Reinhard Genzel and Andrea Ghez

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