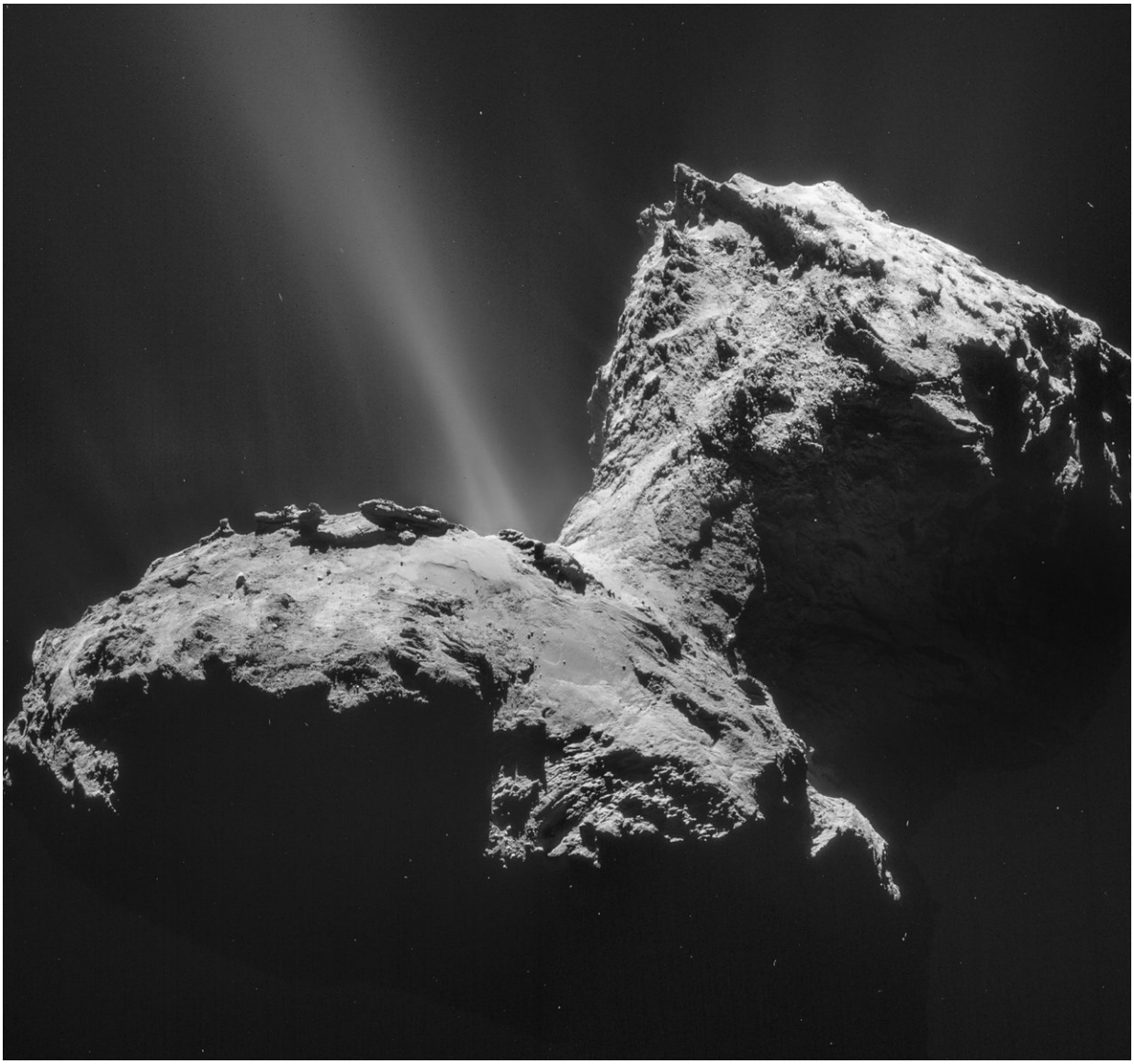
Rosetta spacecraft detects unexpected ultraviolet aurora at a comet

September 21 2020



Data from Southwest Research Institute-led instruments aboard ESA's Rosetta

spacecraft helped reveal unique ultraviolet auroral emissions around irregularly shaped Comet 67P. Although these auroras are outside the visible spectra, other auroras have been seen at various planets and moons in our solar system and even around a distant star. Credit: ESA/Rosetta/NAVCAM

Data from Southwest Research Institute-led instruments aboard ESA's Rosetta spacecraft have helped reveal auroral emissions in the far ultraviolet around a comet for the first time.

At Earth, auroras are formed when charged particles from the Sun follow our planet's magnetic field lines to the north and south poles. There, solar particles strike atoms and molecules in Earth's atmosphere, creating shimmering curtains of colorful light in high-latitude skies. Similar phenomena have been seen at various planets and moons in our solar system and even around a distant star. SwRI's instruments, the Alice far-ultraviolet (FUV) spectrograph and the Ion and Electron Sensor (IES), aided in detecting these novel phenomena at comet 67P/Churyumov-Gerasimenko (67P/C-G).

"Charged particles from the Sun streaming towards the comet in the solar wind interact with the gas surrounding the comet's icy, dusty nucleus and create the auroras," said SwRI Vice President Dr. Jim Burch who leads IES. "The IES instrument detected the electrons that caused the aurora."

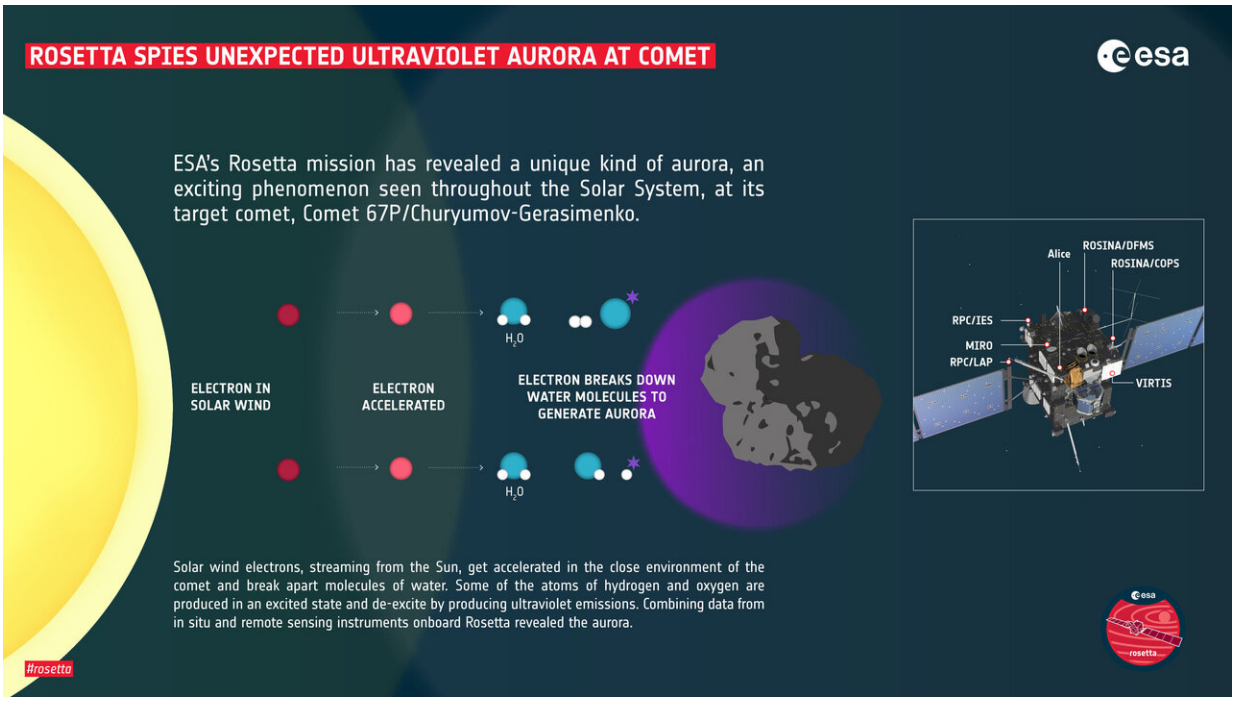
The envelope of gas around 67P/C-G, called the "coma," becomes excited by the solar particles and glows in ultraviolet light, an interaction detected by the Alice FUV instrument.

"Initially, we thought the ultraviolet emissions at comet 67P were phenomena known as 'dayglow,' a process caused by solar photons

interacting with cometary gas," said SwRI's Dr. Joel Parker who leads the Alice spectrograph. "We were amazed to discover that the UV emissions are aurora, driven not by photons, but by electrons in the solar wind that break apart water and other molecules in the coma and have been accelerated in the comet's nearby environment. The resulting excited atoms make this distinctive light."

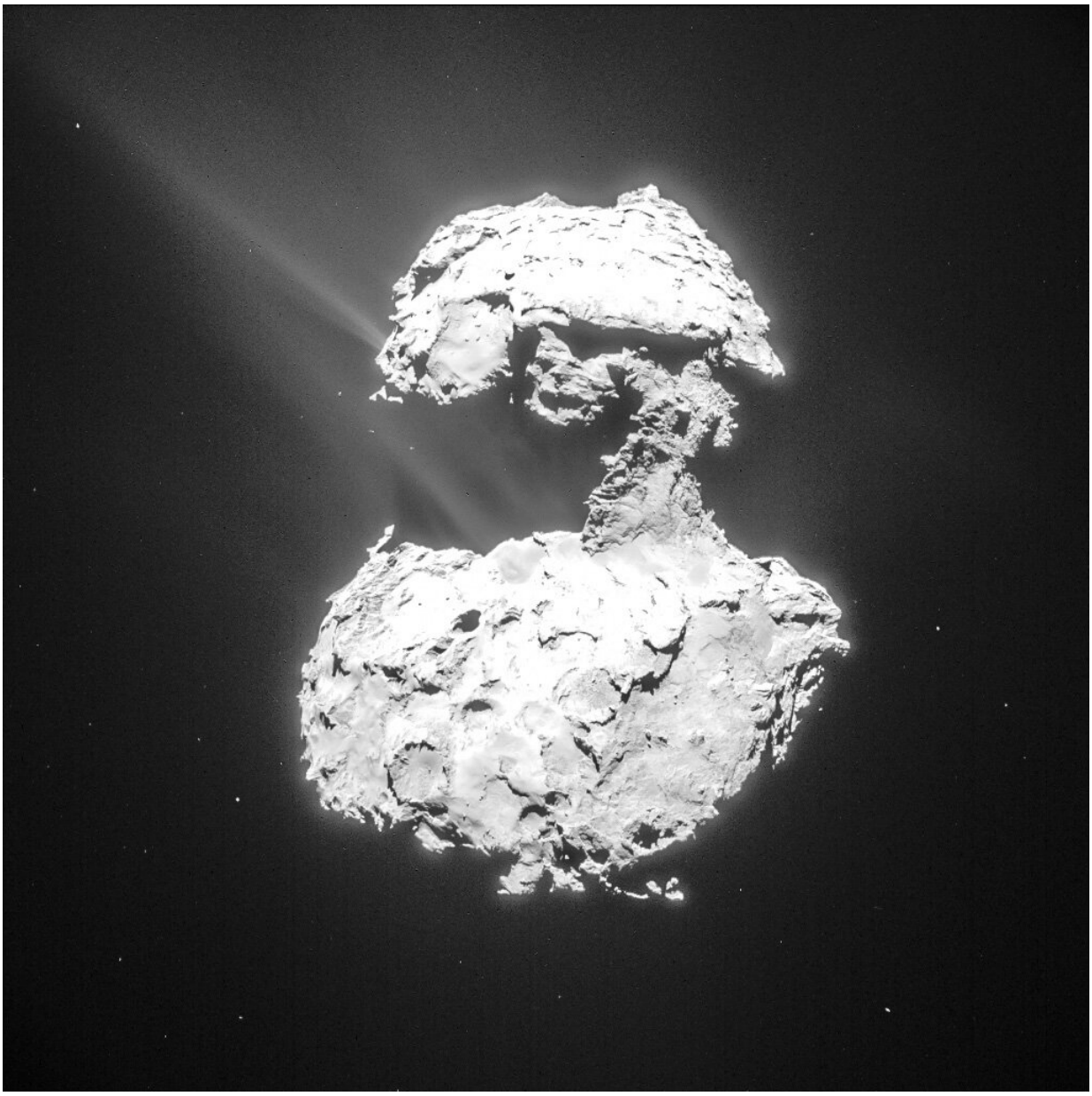
Dr. Marina Galand of Imperial College London led a team that used a physics-based model to integrate measurements made by various instruments aboard Rosetta.

"By doing this, we didn't have to rely upon just a single dataset from one instrument," said Galand, who is the lead author of a *Nature Astronomy* paper outlining this discovery. "Instead, we could draw together a large, multi-instrument dataset to get a better picture of what was going on. This enabled us to unambiguously identify how 67P/C-G's ultraviolet atomic emissions form, and to reveal their auroral nature."



This image shows the key stages of the mechanism by which this aurora is produced: as electrons stream out into space from the Sun and approach the comet, they are accelerated and break down molecules in the comet's environment. Some of the atoms of hydrogen and oxygen are produced in an excited state and de-excite by producing ultraviolet emissions, the observed aurora. The auroral nature of the emissions has been revealed from the analysis of observations from a set of in situ and remote-sensing instruments aboard Rosetta (RPC, ROSINA, VIRTIS, MIRO and Alice). Credit: ESA (spacecraft: ESA/ATG medialab)

"I've been studying the Earth's auroras for five decades," Burch said. "Finding auroras around 67P, which lacks a magnetic field, is surprising and fascinating."



Gas and dust rise from Chury's surface as the comet approaches the point of its orbit closest to the Sun. Credit: ESA/Rosetta/NAVCAM

Following its rendezvous with 67P/C-G in 2014 through 2016, Rosetta has provided a wealth of data revealing how the Sun and solar wind interact with comets. In addition to discovering these cometary auroras,

the spacecraft was the first to orbit a comet's nucleus, the first to fly alongside a comet as it travelled into the inner Solar System and the first to send a lander to a comet's surface.

More information: Far-ultraviolet aurora identified at comet 67P/Churyumov-Gerasimenko, *Nature Astronomy*, DOI: 10.1038/s41550-020-1171-7 , www.nature.com/articles/s41550-020-1171-7

Provided by Southwest Research Institute