

Astrophysicist contributed into internationalteam efforts on study Comet 29P

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The observation of Comet 29P -- the so-called Centaur object -- was carried out in the course of the Comet activity when the brightness of the celestial body increases for hundreds of times. Credit: Michael Hauss

Evgenij Zubko of Far Eastern Federal University (FEFU), in collaboration with international team members, has developed a



comprehensive model to explain the results of the recent photometric study of the comet Schwassmann-Wachmann 1 (29P). The surprising findings revealed that the dust environment of 29P predominantly consists of only one type of material—magnesium-rich silicate particles with presumably a small amount of iron (Fe-Mg silicates).

The observation of Comet 29P, a so-called centaur object, was carried out during a period when its brightness increased by hundreds of times as a result of sudden and little-understood outburst activity. The results have been published in *Icarus*.

Evgenij Zubko, a lead research scientist at the FEFU School of Natural Sciences, said, "We analyzed the scattering of light by particles of irregular shape in the inner coma of the 29P. To do so, we performed simultaneous modeling of the color measured in pairs of filters B-R and R-I. The model of light scattering built on the basis of this computation helped us to draw a conclusion about the chemical composition of cometary dust. Comparing the value of the imaginary part of refractive index with what is already known from laboratory studies of various analogs of cometary dust, we end up with a confident conclusion that the dust environment of this comet is almost 100 percent formed of magnesium-rich silicates with a small impurity of iron (Fe). The volume of other possible impurities is extremely minor. What is truly significant it is that this type of material was detected in comets by space probes. Furthermore, the retrieved size distribution of dust particles in 29P also appears in excellent accordance with in situ studies. Thus, we have drawn a very much self-consistent picture of the comets."

Except for 29P, there is the only one other example of a comet with a single-component dust coma—comet 17P/Holmes. Like 29P, Holmes periodically experiences outbursts presumably as a result of the inner CO and CO_2 outgassing.



To perform the 29P study, the scientists measured the color of the sunlight reflected from its coma using broadband filters adjusted to blue (B), green (V), red (R) and infrared (I) bands. The analysis is based on comprehensive modeling of light scattering by cometary dust particles with various shapes, size distributions, and refractive indices. However, information about the color of comets is clearly insufficient for classification. The point is that with the same chemical composition that is described in terms of the refractive index, the color of a comet may vary significantly during a short time period due to temporary variations in the size distribution of cometary dust particles. Evgenij Zubko says that this time, the team made a breakthrough in retrieving the chemical composition of the dust.

The team has provided an important constraint on the chemical composition of the 29P coma. The findings surprised the scientists due to the fact that the dust environment of 29P consists of only one type of material. Two-component mixtures are more usual.

29P belongs to a special class of objects, the so-called centaurs. Like mythological centaurs, comets like 29P have a dual nature: They move in a nearly circular orbit, which is atypical for comets—such orbits are usual for large asteroids and planets.

The nearly circular orbit of 29P is due to its origin in the Kuiper Belt. There is some evidence that the comet may originate from the Oort Cloud. This an extremely remote region located at a distance of almost 100,000 AU from the sun—approximately one light-year. Comets that currently settle in the Oort Cloud are believed to have been thrown there in the early stages of the solar system when it was only forming. They may spend in the Oort Cloud several billion years. Under the effect of various factors, such comets sometimes may return back into the inner part of the Solar System where the Earth is located.



Further study of the chemical composition of the 29P nucleus is aimed to determine more accurately which part of the Solar System the comet originates from.

Evgenij Zubko emphasizes that comets are among the oldest objects in the solar system. Some of them get formed when the sun had not yet become a star, which means they should have very much primordial composition, whereas the billions of years spent by comets in the Oort Cloud may preserve their ancient composition. Comets therefore offer a chance to look into the history of the solar system. Currently, there are several known groups of comets with significantly different properties. Explaining of these differences is aimed to help scientists better understand how the solar system evolved and which processes took place in it 4 to 5 billion years ago.

More information: Enos Picazzio et al, Comet 29P/Schwassmann-Wachmann 1 dust environment from photometric observation at the SOAR Telescope, *Icarus* (2018). <u>DOI: 10.1016/j.icarus.2018.09.008</u>

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