Weird Crater Rays

Lunar rays were first depicted in the 1629 drawings of Italian observer Francesco Fontana, but their origin remained controversial for centuries. In 1907, experienced German observer Phillipp Fauth glumly concluded that lunar rays mock all attempts at understanding. But since the early 1960s we have known that rays are made of pulverized material ejected during the formation of impact craters.

As described in last month’s column, the brightness of rays is due to two separate causes that have been only recently understood. Some rays, called compositional rays, are bright because they are made of aluminum-rich highland rock debris. Others are conspicuous because they are made of recently (in geologic terms) pulverized materials that are relatively reflective. And of course, some rays are bright for both reasons.

Presumably all lunar craters produced rays when they formed, but the fact that most of them lack these features today implies that some mechanism causes rays to disappear. After a billion years or so the ray fragments made from pulverized material are darkened by space weathering and lose their reflectivity. Compositional rays fade for this reason and also because small impacts physically mix the ray material with the surrounding darker lunar surface. This second kind of fading takes longer to occur — perhaps as much as 3 billion years. It was once thought that all craters with rays were less than a billion years old, but now we understand that craters with compositional rays may be considerably older. The ray systems of Eudoxus, Aristillus, and Pythagoras are examples of old compositional rays.

The bright rays streaming from Copernicus and Tycho are well-known lunar delights, but there are many fainter ray systems that require more careful observing to detect. Classical observers, intent upon cataloging all lunar features, included lists of ray craters in their books about the Moon. In 1895 Thomas Gwyn Elger listed 79 rayed craters, and by 1936 Fauth had tabulated 304. Today, few observers notice most of these faint rays, but some of them are actually quite easy to find.

One faded ray system radiates westward across Mare Fecunditatis from the 132-kilometer-wide crater Langrenus (L85 in the Lunar 100). These rays extend about three crater radii beyond the rim of Langrenus, and when the Moon is near full, they are bright enough to be spotted with only a little difficulty. The Langrenus rays are of the compositional type and thus may be considerably older than 3 billion years.

Another, even fainter ray system is just detectable on southern Mare Imbrium, radiating from Eratothenes. At full Moon this crater is virtually invisible and only a few
faint short rays can be seen. Part of the problem is that the region is nearly satu-
rated with younger rays from Copernicus, making the identification of Eratosthenes' rays even more difficult.

The most unusual ray system on the Moon is also one of the least well known. The 18 km-wide crater Dionysius (L93) lies right on the western shore of Mare Tran-
quillitatis and has a family of rays that extend 60 to 70 km from the crater rim.
The remarkable thing about these rays is that they are dark, not bright. The anom-
alous rays were not noted by classical lunar observers. Recently B. Ray Hawke and
Tom Giguere (University of Hawaii) and their colleagues determined that these fea-
tures are compositional rays. But why are they dark?

It appears the Dionysius impact ejected dark, basaltic mare fragments as rays onto
the surrounding bright plains. If you look carefully you will notice something else: Dionysius is enveloped by a halo of intermediate-brightness material. This is
actually highland rock debris that was excavated from below the layer responsible
for the ray material. With excellent seeing and high magnification you can see that
the halo covers the rays, demonstrating that the ray material was ejected first and
then was buried by the halo material excavated from deeper underground. +

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