BRIEF COMMUNICATIONS

A martian meteor and its parent comet

An image of an extraterrestrial meteor was captured as a strange streak in the sky over Mars last year.

Regular meteor showers occur when a planet approaches the orbit of a periodic comet — for example, the Leonid shower is evident around 17 November every year as Earth skims past the dusty trail of comet Tempel–Tuttle. Such showers are expected to occur on Mars as well, and on 7 March last year, the panoramic camera of Spirit, the Mars Exploration Rover, revealed a curious streak across the martian sky. Here we show that the timing and orientation of this streak, and the shape of its light curve, are consistent with the existence of a regular meteor shower associated with the comet Wiseman–Skiff, which could be characterized as martian Cepheids.

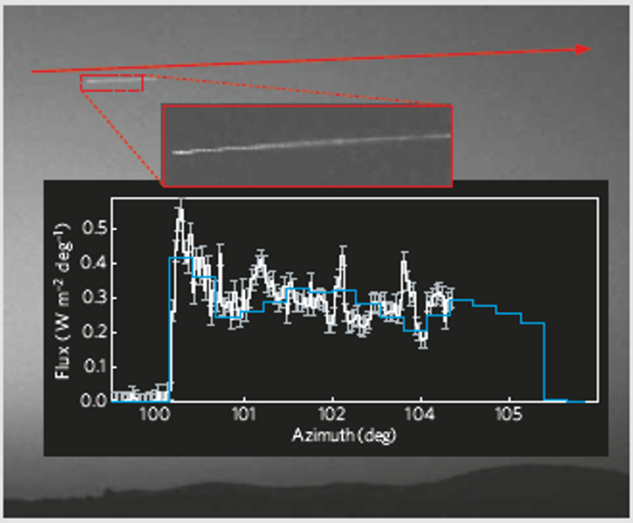

Figure 1 | Image and light curve from the panoramic camera of Spirit, the Mars Exploration Rover. The streak in the inset image 2P131930937RAD1300P2733L5C2.IMG (ref. 8) is shown in the context of a larger, associated Navcam image. The arrow indicates the predicted direction of a meteor emerging from the predicted radiant in the Cepheus constellation. The plot shows the light curves measured along the streak, taken from the Navcam image (blue curve; each point represents 16 pixels) and from the inset image (white curve with error bars; each point represents 2 pixels). The flux is integrated over a 19-nm spectral band centred at 535 nm.

On the basis of its orbital elements, comet Wiseman-Skiff is among the top five candidates for producing a regular martian meteor shower[1,2]. A shower associated with this comet was predicted[1] for 11 March 2004, less than four days after the Spirit picture of the streak (Fig. 1) was taken. As mean regular showers typically last for several days or more, we investigated the possible link between the observed streak and this particular comet.

Meteors from one parent body all seem to emerge from the same point in the sky, called the radiant. Owing to varying velocities in the particle stream, the radiant is not a single point but is typically a few degrees in diameter. The streak seen by Spirit defines a great circle on the sky that passes only 4° from the radiant associated with the orbit of comet Wiseman-Skiff (right ascension, 329.14°; declination, 59.61°; in the constellation Cepheus). More than 96% of all possible radiants produce worse alignments.

This radiant was 10.6° below the horizon, but that still allows the observation of grazing meteors (that is, meteors with a high zenith angle). The radiant could even have been positioned up to 15–20° below the horizon, given the expected range of meteor altitudes (50–100 km; ref. 3) and taking into account the gravitational deviation of the meteoroids from comet Wiseman–Skiff, which travel at relative speeds of 11 km s^{-1}.

The low elevation (14.2°) of the streak, the fact that its trajectory is roughly parallel to the horizon, and its large angular separation from the radiant (111–115°) are typical features of grazers. We therefore suggest that the streak is a grazing meteor that passed 200–300 km from Spirit, with an observed travel of 13–24 km (4.0° of arc).

The recorded light curve (Fig. 1) is comparable to that of some observed terrestrial meteors[4,5]. It is characterized by an early peak (assuming that the meteor emerges from Cepheus) and a very sharp initial edge: a 2.5-magnitude change in less than 0.25° (the other edge is truncated by the 15-second exposure). Both effects are expected for high zenith angles[5,6], but the abruptness of the edge also requires a slow meteoroid that has a relative speed below 25 km s^{-1}. This is consistent with the 11 km s^{-1} mean relative speed of particles from comet Wiseman–Skiff.

During the terrestrial 1998 and 2002 Leonids there were sharp peaks of activity, due to Earth's interception of dense swarms of particles ejected by Tempel–Tuttle. Using a model for particle ejection and dynamic evolution[7], we searched for similar events due to Mars's interception of particle swarms from specific perihelion passages of Wiseman–Skiff. We traced the ejected swarms back to 1900 and found no particular event that could have contributed to a 2004 shower, although there is a promising interception for 20 December 2007. This suggests that the observed meteor belongs to the annual stream responsible for a regular shower, but not to a specific swarm ejected after 1900.

It is therefore likely that we have identified the first martian meteor and its parent comet. Our findings indicate that martian meteor showers may now be predictable events. Further observations could reveal the chemical effects of meteors on an atmosphere rich in carbon dioxide, a topic pertinent to early Earth's atmospheric chemistry.

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