MAVEN Observations of the Aftermath of Comet Siding Spring's Meteor Shower.

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Abstract: Two instruments onboard the MAVEN mission report the unambiguous detection of metal species in Mars' upper atmosphere immediately following the close approach by Comet Siding Spring on 19 October 2014.

The Imaging Ultraviolet Spectrograph (IUVS), a remote sensing instrument, detected intense emission from magnesium and iron in Mars's atmosphere immediately following the Comet Siding Spring meteor storm. Ionized magnesium caused the brightest emission from the planet for many hours (see Figure 1), resulting from resonant scattering of solar ultraviolet light. The observations led to the following preliminary results:

- The brightest emissions of tens of kiloRayleighs in orbit 116 imply densities of >=10^4 Mg^+/cm^3 peaking around 115km;
- Emission was detected globally over the following day with significant spatial/temporal structures;
- Hemispheric integration of initial Mg^+ densities yields ~16,000 kg of cometary dust deposited;
- Penetration depth suggests particle sizes up to 10-100 microns of "fluffy", low-density composition;
- Total dust mass, particle size distribution and shower duration together yield zenithal hourly rates of visible meteors of thousands to tens of thousands per hour.

The resulting ionization created a new ionospheric layer below Mars' main dayside ionosphere that persisted for at least 36 hours. The vaporized dust is expected to react with the local atmosphere to make meteoric smoke that will remain in the atmosphere for several years. The dramatic meteor shower response at Mars is starkly different from the case at Earth, where a steady-state metal layer is always observable and even the strongest meteor showers cause no perceptible perturbations.

MAVEN's Neutral Gas and Ion Mass Spectrometer NGIMS also made observations before and after the comet encounter, and discovered several metal ions that disappeared after several orbits. The ion signal from cometary dust ablating in the atmosphere in Figure 2 shows just one of these ions. The enhanced neutral density observed just above 200 km is likely due to heating and expansion of the atmosphere with cometary coma material.

In theaftermath of these observations, we are left with several fundamental questions about the physics of meteor showers on Earth and Mars, as well as about the comet itself:

- What can we learn about Oort cloud comets from this unexpectedly large dust flux?
- What causes the vertical and regional structures?
- Why doesn't Mg rise as Mg^+ falls so rapidly? Is Mars' metal chemistry different?
- Does Mars lack a steady-state metal layer from "sporadics"?
- How & why are Mars' meteor showers different from Earth's?
- Will MAVEN see other meteor showers at Mars?

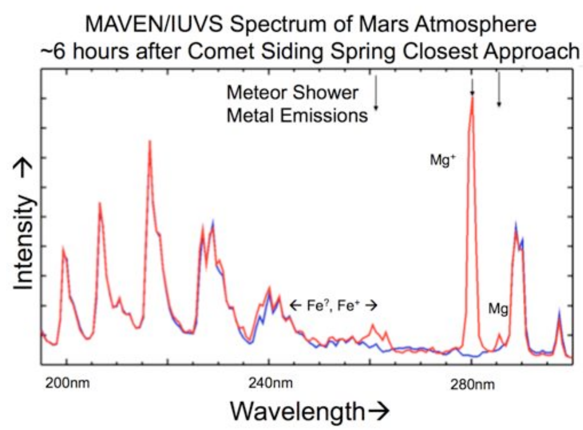

Figure 1. Spectrum of Mars atmosphere before (blue) and after (red) the passage of Comet Siding Spring by Mars. Metal species are indicated.

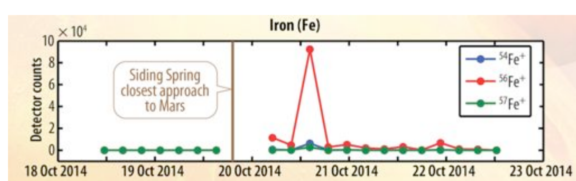

Figure 2. Iron ions measured by NGIMS during its periapse; each dot represents a separate orbit and the vertical line shows the time of the closest approach.