Finding Debris Clouds Around Asteroids Headed Our Way

Small spikes in the solar system's magnetic field may help scientists detect overlooked and possibly dangerous debris clouds around near-Earth asteroids.

An artist's rendition of a fragmented asteroid. Credit: NASA/JPL-Caltech

By Lucas Laursen 19 hours ago

Small spikes in the magnetic field in our solar system may reveal dust and debris, including some on a collision path with Earth, according to a researcher at the European Geosciences Union (EGU) General Assembly in Vienna, Austria.

The solar wind, which consists of charged particles flowing at high speed from the Sun, creates a magnetic field detectable from interplanetary space probes. Planetary scientist Christopher Russell of the University of California in Los Angeles and his colleagues have been examining small wrinkles in that magnetic field called interplanetary field enhancements (IFEs) since the 1980s. At an EGU session (http://meetingorganizer.copernicus.org/EGU2015/orals/17357) on 13 April, Russell presented the latest evidence that it might be possible to use IFEs to detect asteroid-orbiting clouds of dust and rock, including some that threaten Earth.

"The dust is sort of a warning signal. It's the smoke telling you where the fire is," he told *Eos.*

A Focus on Near-Earth Objects

The explosion of a meteor in the sky near the city of Chelyabinsk, Russia, in 2013 focused attention (http://www.thespacereview.com/article/2277/1) on the need for such signals. The event shook buildings, broke windows, and caused minor injuries, including cuts and sunburns, according to a report (http://www.sciencemag.org/content/342/6162/1069.abstract) in *Science*.

In response, the U.S. Congress doubled NASA's near-Earth object (NEO) search budget to roughly $40 million a year. In addition, the private B612 Foundation (http://sentinelmission.org/our-story/) in Menlo Park, Calif., is also planning its own mission, dubbed Sentinel (http://sentinelmission.org/sentinel-mission/overview/), to detect more NEOs. The Sentinel team is promoting 30 June 2015 as Asteroid Day (http://www.asteroidday.org/), *Eos* reported (https://eos.org/articles/group-calls-focus-potentially-hazardous-asteroids) late last year.

Objects smaller than that are probably much more common than earlier estimates, according to a slew of new studies last year.
NASA claims that it has detected and is tracking the majority (http://neo.jpl.nasa.gov/stats/) of NEOs larger than 1 kilometer in size. In addition, it aims to detect 90% of objects down to 140 meters. Objects smaller than that are probably much more common than earlier estimates, according to a slew of new studies (http://spectrum.ieee.org/tech-talk/aerospace/astrophysics/chelyabinsklike-impacts-more-common-than-scientists-thought) last year. The studies indicate that these small NEOs can still cause major damage (https://www.purdue.edu/impactearth).

Seeing into the Shadows

Today's detection efforts rely on radar and optical telescopes. However, optical methods depend on light reflected from very dark objects, and for radar and optical instruments the smaller targets are more difficult to detect.

Known NEOs may be co-orbited by debris large enough to cause damage on Earth even if the host objects miss Earth.

Russell pointed out during his talk that known NEOs may be co-orbited by debris large enough to cause damage on Earth even if the host objects miss Earth. For example, one estimate put the Chelyabinsk meteor at only 17 meters. An object that size could be difficult to detect via conventional methods if it were hiding in the shadow of a much larger asteroid.

However, because such objects are likely the result of recent collisions, Russell says they are likely to be accompanied by smaller debris and fine dust. This dust may be the key to identifying these small objects co-orbiting with NEOs.

A New Method

Russell argued during his presentation (http://meetingorganizer.copernicus.org/egu2015/egu2015-3051.pdf) that nanoscale particles from such collisions pick up charges and interact in a detectable way with the solar wind. Earlier this year his team published a paper (http://onlinelibrary.wiley.com/doi/10.1002/2015GL063302/abstract) in *Geophysical Research Letters* that used magnetometer data from five spacecraft to document momentum transfer from the solar wind to a dust cloud. The multiple perspectives from all those spacecraft made it possible to triangulate the location of the IFEs and put some boundaries on their three-dimensional structure.

At the EGU meeting, Russell reported that the team has associated two specific IFEs with two different objects: asteroid 2201 Oljato (http://ssd.jpl.nasa.gov/sbdb.cgi?sstr=2201+Oljato) and the potentially hazardous (http://neo.jpl.nasa.gov/orbits/) asteroid 138175 (http://ssd.jpl.nasa.gov/sbdb.cgi?sstr=138175;orb=1). Asteroid 2201 Oljato does not threaten Earth yet, but asteroid 138175 is on NASA's watch list.

Getting a handle on the dust cloud size will help researchers predict the mass and distribution of matter within and surrounding NEOs.

"We want to quantify the size of the cloud of dust," Russell says. Getting a handle on the dust cloud size will help researchers predict the mass and distribution of matter within and surrounding NEOs. That could help guide targeted observations with higherresolution optical telescopes to determine whether the dust cloud is hosting any potentially hazardous co-orbiting objects, Russell explained.

If the researchers can establish the relationship between the strength of magnetic disturbances and dust cloud size, the magnetometer data already pouring back from many interplanetary missions could be a rich source of information for fine-tuning Earth's planetary defense.

More Perspectives on IFEs' Link to Asteroids

Geraint H. Jones of Imperial College London in the United Kingdom has also examined IFEs in data from the Ulysses spacecraft. In 2003, he and colleagues reported (http://www.sciencedirect.com/science/article/pii/S0019103503002884) in *Icarus* that IFEs trailed comets, not asteroids. The charges that modified the solar wind's magnetic field probably came from ions the comet emitted, Jones says.

If IFEs only trail comets–which are larger, easier to detect, and cross Earth's path less frequently than asteroids–they may be less useful for planetary defense. However, in the case that Russell and colleagues reported, "charged dust essentially behaves like a very, very heavy ion," Jones told *Eos*.

Jones said Russell's study with "the multiple points of view from five spacecraft: that's made a big difference. It does appear that dust has an effect on the solar wind and it's, I think, larger than people would have expected otherwise." That said, he says he would next like to see a model of the physics of asteroid impacts, dust clouds, and IFEs that predicts the observations.

Russell says he wants to obtain multiple detections of an IFE associated with an asteroid to conclude that the signal is coming from dust activity and to repeat the observation for multiple objects. He says the team is now selecting likely targets for observation on the basis of their paths and orbital periods. Then they will conduct simulations of how such debris clouds form around NEOs in the first place.

The method is also limited by the fact that detecting IFEs is possible only when the object passes between the Sun and a space-based magnetometer. Because most asteroids orbit beyond Mars, surveying them would require very far-flung spacecraft.

However, if Russell's team can make a convincing link between IFEs and the halos of debris around NEOs, the next logical step, Russell says, is “just going down the list of asteroids” to see which known NEOs have potentially dangerous orbiting debris clouds.

—Lucas Laursen, Freelance Writer; Twitter: @lucaslaursen (https://twitter.com/lucaslaursen)

Citation: Laursen, L. (2015), Finding debris clouds around asteroids headed our way, *Eos, 96,* doi:10.1029/2015EO028309 (http://sfx.hul.harvard.edu/hvd?url_ver=Z39.88-2004&rft_val_fmt=info:ofi/fmt:kev:mtx:journal&__char_set=utf8&rft_id=info:doi/10.1029/2015EO028309&rfr_id=info:sid/libx%3Ahul.harvard&rft.genre=article). Published on 20 April 2015.