Naval Research Laboratory patents compact orbital debris sensor

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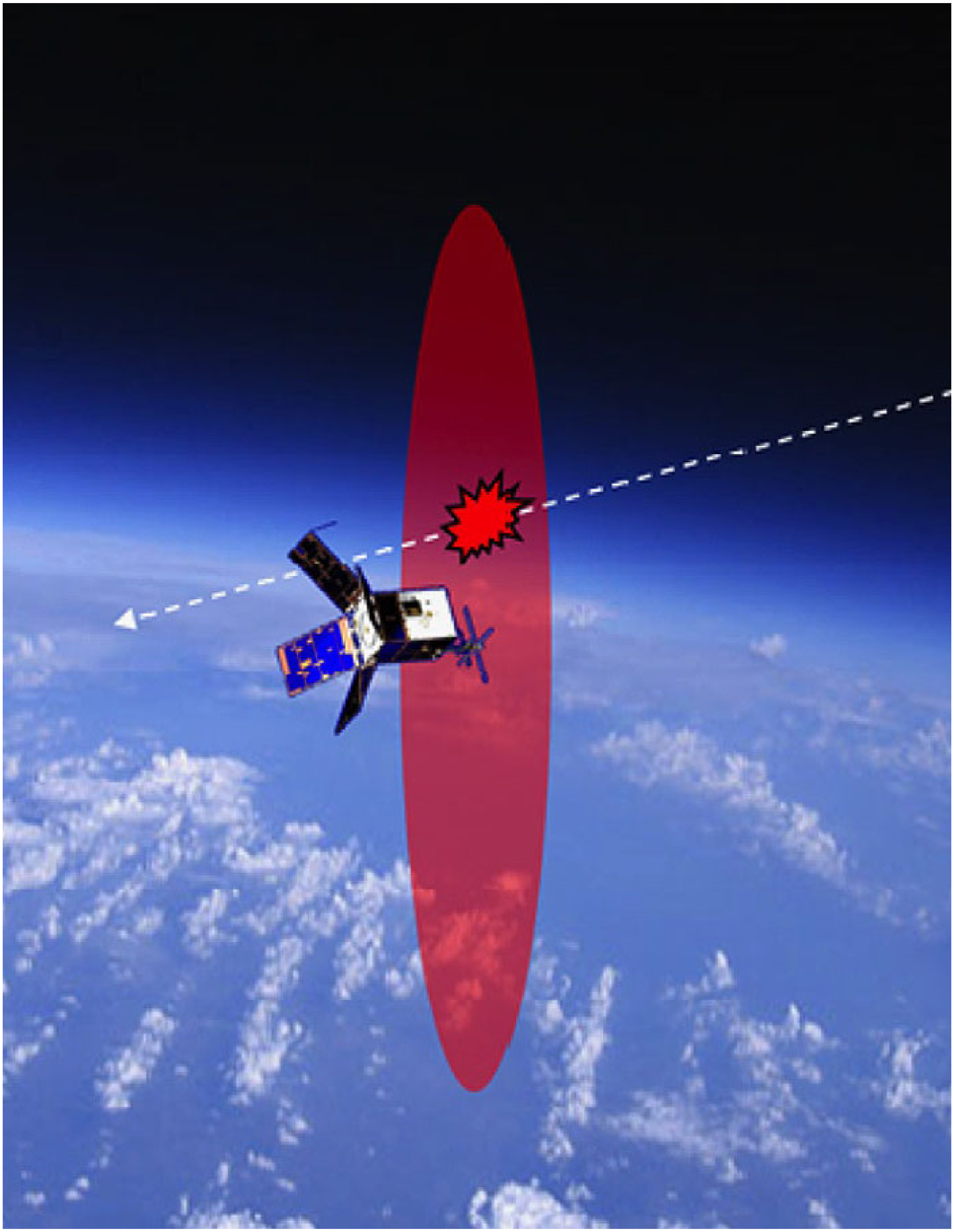


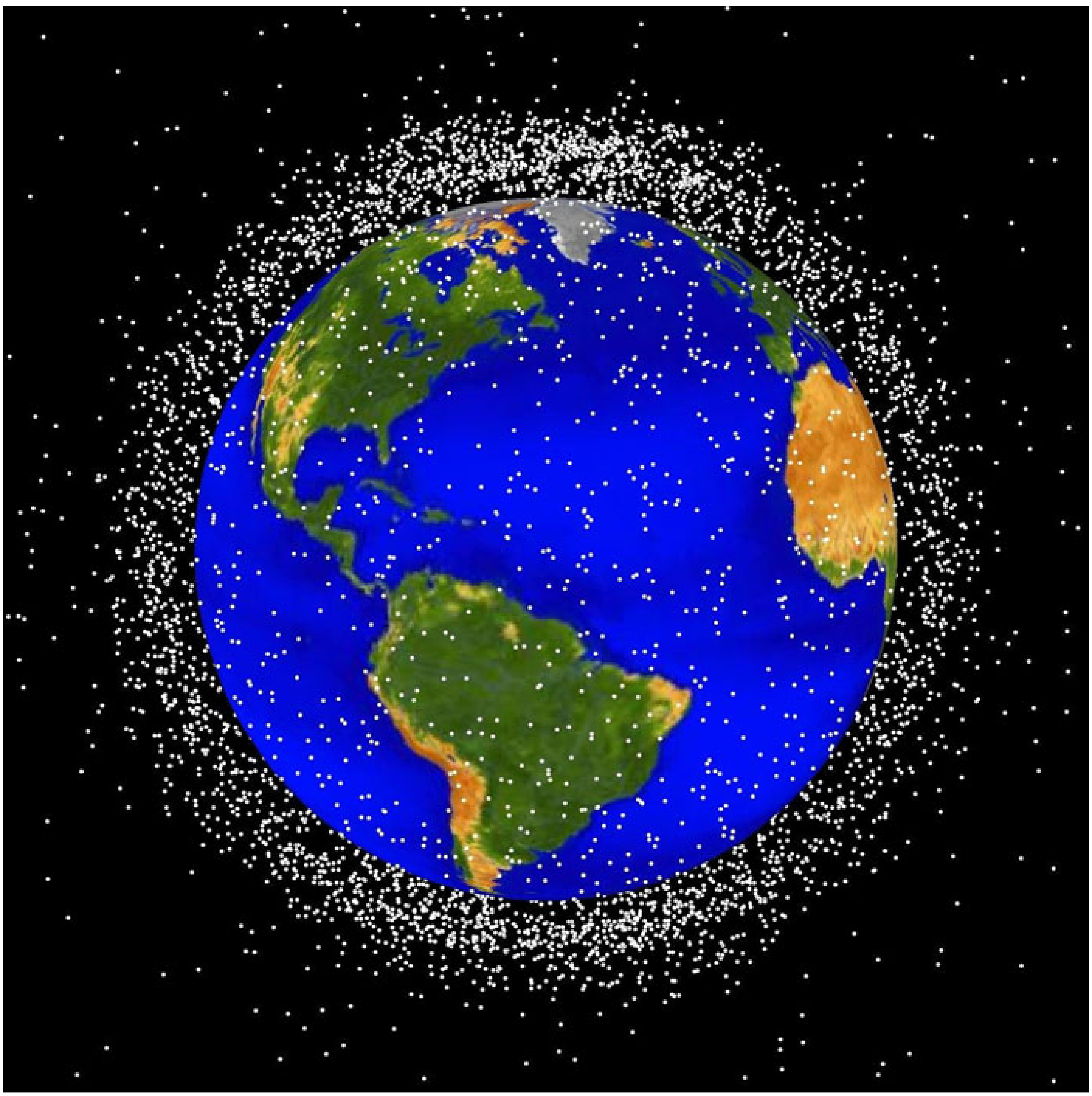
The Optical Orbital Debris Spotter is capable of detecting debris with sizes as small as about 0.01 centimeters in the vicinity of a host spacecraft for near real-time damage attribution and characterization of dense debris fields. The small sensor can then potentially provide additional data to compliment existing debris models such as the Space Surveillance Network. Image: The red disk illustrates the laser light sheet. The arrow represents the trajectory intersecting the light sheet. Credit: US Naval Research Laboratory

The U.S. Naval Research Laboratory (NRL), Geospace Science and Technology Branch, has received a U.S. patent for the Optical Orbital Debris Spotter, a compact, low power, low cost, local space debris detection concept that can be integrated into larger satellite designs, or flown independently on-board nano-satellite platforms.

The number of man-made debris objects orbiting the Earth continues to increase at an alarming rate—with objects smaller than one centimeter (cm) exceeding 100 million. The effects of collisions occurring at orbital velocities, approaching several kilometers per second, can range from minor to catastrophic. In Low Earth Orbit (LEO), where many space-based assets reside, small debris objects are of concern not only due to their abundance, but because they are often difficult to track or even detect on a routine basis.

The fundamental concept for the orbital debris detection sensor is to create a continuous light sheet by using a collimated light source, such as a low power laser, and a conic mirror. The key idea of this concept is to form a permanently illuminated light sheet rather than scanning a beam. This way, all particles intersecting the beam will scatter the light from the source, independent of the time of intersection with the plane of the light sheet.

"When the flight path of an orbital debris object intersects the light sheet, the object will scatter the light, and a portion of that scattered light can be detected by a wide angle camera," said Dr. Christoph Englert, research physicist at NRL. "The knowledge of the light sheet geometry and the angles of the scattering event with respect to the camera, derived from the signal location on the sensor, allow the determination of the intersection point, and possibly even size, and shape information about the debris particle."



Low Earth Orbit (LEO) is the region of space within 2,000 kilometers of the Earth's surface. It is the most concentrated area for orbital debris. The U.S. Strategic Command (USSTRATCOM) estimates that since the launch of Sputnik in 1957, over 39,000 man-made objects have been catalogued, many of which have since re-entered the atmosphere. Currently, the Joint Space Operations Center (JSpOC), responsible for maintaining the Space Surveillance Network (SSN), tracks more than 16,000 objects orbiting Earth. About five percent of those being tracked are functioning payloads or satellites, eight percent are rocket bodies, and about 87 percent are debris and/or inactive satellites. Credit: U.S. Strategic Command, Joint Space Operations Center

Many debris studies are performed using damaged satellite surfaces that are brought back to the Earth after months or years in orbit. This newly patented concept can provide, at a minimum, a similar or even improved data set in close to real-time without the necessity of returning satellites back to Earth. Small, stand-alone sensor systems, such as the optical orbital debris spotter, could also be deployed within a debris cloud to provide in-situ measurements of debris density, distribution and evolution.

"Using a dedicated nano-satellite, or CubeSat, the system could also be used for gathering of more comprehensive debris field data," Englert said. "Losing the satellite at some point during the mission by a fatal collision could be considered a justifiable risk in comparison to the odds of getting unprecedented data sets for debris field characterization and modeling."

The sensor concept, weighing approximately two kilograms and measuring approximately 10cm x 10cm x 20cm, depending on specific implementation, could gather valuable input for modeling and prediction software that is starved for information on small debris pieces. These data sets could then be incorporated into global space tracking tools such as the Space Surveillance Network (SSN), NASA's Orbital Debris Engineering Model (ORDEM), and the European Space Agency's Optical Ground Station.

Provided by Naval Research Laboratory

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