

Laser communication systems

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Lasers could one day carry interplanetary communication signals between Earth and Mars.

Current Mars rovers and satellites send and receive signals from Earth via radio waves at a data rate of a few megabits per second^[1]. If lasers could be used instead, the transmission would form a tighter beam, with more of the total energy being delivered to the receiving antenna and less wasted. This means a higher data rate, for the same power consumption^[2]. With current technology, at Earth-Mars range, a laser could increase bandwidth by a factor of 10 compared to radio waves, making high-definition video streams possible. Future refinements in the technology could lead to a data rate 100 times that of radio waves^[1].

Laser communication has never been tried at this distance. NASA plans to test long-distance communication using an infrared laser in conjunction with an upcoming mission (https://www.nasa.gov/mission_pages/tdm/dsoc/index.html) that will send a probe to an asteroid, scheduled to launch in 2022 and arrive at its destination in 2026.

A new Deep Space Network antenna currently under construction will have dual functionality for both radio and laser signals^[1].

Engineering challenges for Earth-Mars laser communication include interference from sunlight, precise pointing of the narrow beam despite spacecraft motion and vibrations^[2], interference from Earth's atmosphere, space temperature extremes, radiation, and forces on delicate equipment during launch^[1].

Alternatively, if enough power is available then radio communications may continue to be used for high bandwidth communications.

References

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2. Seffers, G.I., 2018, NASA Counts Down to Laser Communications for Mars, *SIGNAL Magazine*, <https://www.afcea.org/content/nasa-counts-down-laser-communications-mars>.

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