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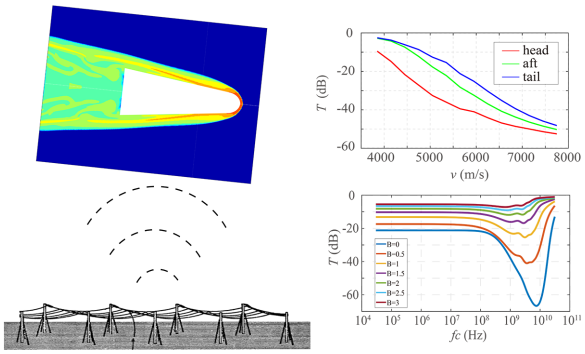
**Low-frequency signals, like those used in underwater communications, can mitigate the communication blackout experienced by hypersonic vehicles in near space.**




Hypersonic vehicles like the space shuttle, X-15 research plane, and some ballistic missiles, travel at least five times the speed of sound. However, speeding through near space at this impressive rate causes plasma to envelope the vehicle, resulting in a communication blackout.

Similar challenges occur when communicating underwater, where low-frequency (LF) signals are used to circumvent this barrier. Mao et al. numerically investigated how LF communication can be applied to penetrate the plasma barrier for hypersonic vehicles.

“A vehicle moving hypersonically in near space forms a shock because the air in front of the vehicle is intensely compressed,” said author Rongxin Tang. “The compressed air releases heat, just like the compressor in a refrigerator or air conditioner, heating the surrounding air to several thousands of Kelvins. This ionizes the previously neutral air molecules, generating free electrons and ions. That is the so-called ‘plasma sheath.’”

By utilizing wavelengths many orders of magnitude larger than the sheath depth, the authors found that communication was possible. The received signal strength decreases as flight speed increases but was not sensitive to the wave frequency.

LF signals are advantageous for another reason. The ionosphere, which contains charged particles, behaves like a conductor. Because the Earth acts as a ground plane, low frequency waves can efficiently propagate between the two.

“Modern LF transmitters operate at the power of Megawatts, while the ionosphere and the ground form a global wave guide for LF signals,” Tang said. “The LF waves suffer insignificant attenuation in the waveguide. Therefore, it is possible to mitigate the blackout with LF communication using science as well as technique.”

**Source:** “The propagation characteristics of low frequency radio waves in magnetized hypersonic plasma sheaths,” by Mingyang Mao, Kai Yuan, Rongxin Tang, Jiawei Xiong, Ziyang Zhao, and Xiaohua Deng, *AIP Advances* (2023). The article can be accessed at https://doi.org/10.1063/5.0163507.