BepiColombo and Solar Orbiter compare notes at Venus

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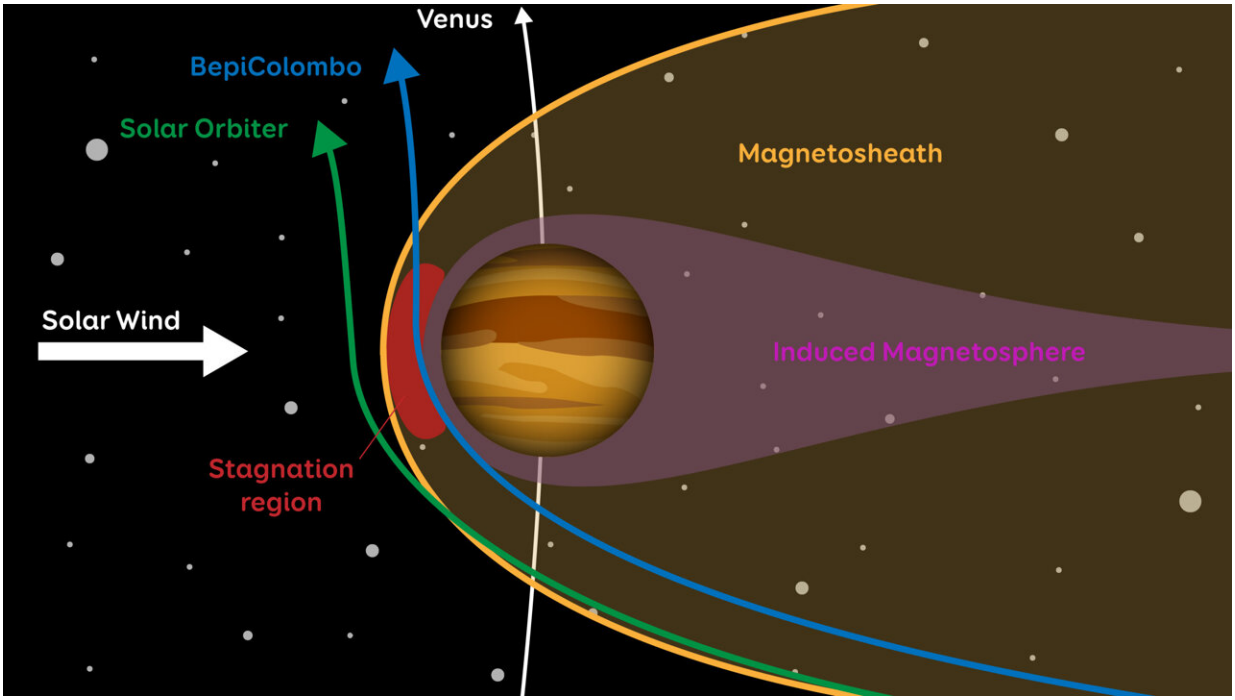

The convergence of BepiColombo and Solar Orbiter spacecraft at Venus in August 2021 was a rare opportunity to investigate the "stagnation region," an area of the Venusian magnetosphere where some of the largest effects of the interaction between Venus and the solar wind are observed. Credit: EuroPlanet Society

The convergence of two spacecraft at Venus in August 2021 has given a unique insight into how the planet is able to retain its thick atmosphere

without the protection of a global magnetic field.

The ESA/JAXA BepiColombo mission, en route to study Mercury, and the ESA/NASA Solar Orbiter, which is observing the sun from different perspectives, are both using a number of gravity-assists from Venus to change their trajectories and guide them on their way. On August 9–10, 2021, the missions flew past Venus within a day of each other, sending back observations synergistically captured from eight sensors and two vantage points in space. The results have been published in *Nature Communications*.

Unlike Earth, Venus does not generate an intrinsic magnetic field in its core. Nonetheless, a weak, comet-shaped "induced magnetosphere" is created around the planet by the interaction of the solar wind—a stream of charged particles emitted by the sun—with electrically charged particles in Venus's upper atmosphere. Around this magnetic bubble, the solar wind is slowed, heated and deflected like the wake of a boat in a region called "magnetosheath."

During the flyby, BepiColombo swooped along the long tail of the magnetosheath and emerged through the blunt nose of the magnetic regions closest to the sun. Meanwhile, Solar Orbiter captured a peaceful solar wind from its location upfront of Venus.

"These dual sets of observations are particularly valuable because the solar wind conditions experienced by Solar Orbiter were very stable. This meant that BepiColombo had a perfect view of the different regions within the magnetosheath and magnetosphere, undisturbed by fluctuations from solar activity," said lead-author Moa Persson of the University of Tokyo in Kashiwa, Japan, who was funded to carry out the study by the European Commission through the Europlanet 2024 Research Infrastructure (RI) project.

BepiColombo's flyby was a rare opportunity to investigate the "stagnation region," an area at the nose of the magnetosphere where some of the largest effects of the interaction between Venus and the solar wind are observed. The data gathered gave the first experimental evidence that charged particles in this region are slowed significantly by the interactions between the solar wind and Venus, and that the zone extends to an unexpectedly large distance of 1,900 kilometers above the planet's surface.

The observations also showed that the induced magnetosphere provides a stable barrier that protects the atmosphere of Venus from being eroded by the solar wind. This protection remains robust even during solar minimum, when lower ultraviolet emissions from the sun reduce the strength of the currents that generate the induced magnetosphere. The finding, which is contrary to previous predictions, sheds new light on the connection between magnetic fields and atmospheric loss due to the solar wind.

"The effectiveness of an induced magnetosphere in helping a planet retain its atmosphere has implications for understanding the habitability of exoplanets without internally-generated magnetic fields," said co-author Sae Aizawa of JAXA's Institute of Space and Astronautical Science (ISAS).

BepiColombo comprises a pair of spacecraft, Mio, the JAXA-led Mercury Magnetospheric Orbiter, and MPO, the ESA-led Mercury Planetary Orbiter, which have been stacked together for the journey to Mercury. The study combined data from Mio's four particle sensors, the magnetometer and another particle instrument on MPO, and the magnetometer and solar wind analyser on Solar Orbiter. Europlanet's SPIDER space weather modeling tools enabled the researchers to track in detail how features in the solar wind observed by Solar Orbiter were affected as they propagated towards BepiColombo through the venusian

magnetosheath.

"The important results of this study demonstrate how turning sensors on during planetary flybys and cruise phases can lead to unique science," said co-author Nicolas Andre, the coordinator of the Europlanet SPIDER service at the Institut de Recherche en Astrophysique et Planétologie (IRAP) in Toulouse, France.

More information: M. Persson et al, BepiColombo mission confirms stagnation region of Venus and reveals its large extent, *Nature Communications* (2022). DOI: 10.1038/s41467-022-35061-3

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