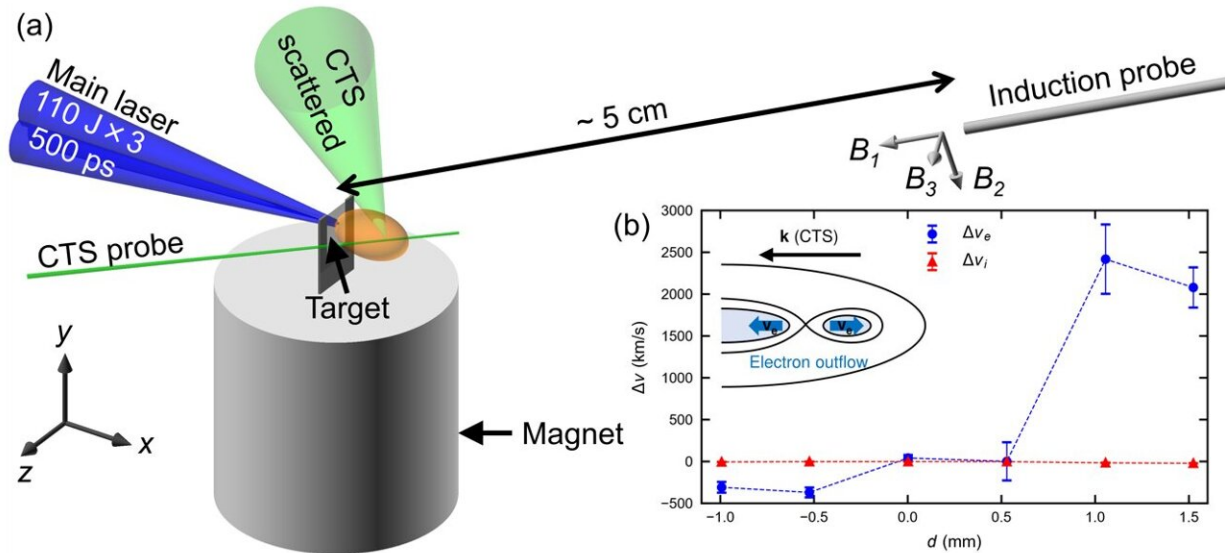


# Laser creates a miniature magnetosphere

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(a) Schematics of the experiment. By irradiating a plastic target with the Gekko XII laser, plasma flow is generated in the presence of a weak magnetic field. The weak magnetic field is distorted by the dynamic pressure of the plasma flow and the anti-parallel magnetic configuration is created. (b) The insert schematically shows that the elongated magnetic field reconnects and releases the magnetic field energy as the reconnection outflows. Pure electron outflows have been measured with CTS for the first time in laser-produced plasmas. Credit: 2022 K. Sakai et al. Direct observations of pure electron outflow in magnetic reconnection. Credit: *Scientific Reports*

Magnetic reconnections in laser-produced plasmas have been studied to understand microscopic electron dynamics, which is applicable to space

and astrophysical phenomena. Osaka University researchers, in collaboration with researchers at the National Institute for Fusion Science and other universities, have reported the direct measurements of pure electron outflows relevant to magnetic reconnection using a high-power laser, Gekko XII, at the Institute of Laser Engineering, Osaka University in Japan. Their findings are published in *Scientific Reports*.

Magnetic reconnection is a fundamental process in many space and [astrophysical phenomena](#) such as [solar flares](#) and magnetic substorms, where the magnetic energy is released as plasma energy. It is known that electron dynamics plays essential roles in the triggering mechanism of magnetic reconnection. However, it has been highly challenging to observe the tiny electron scale phenomena in the vast universe.

Thus, the researchers have created situation-only electrons directly coupled with magnetic fields in laser-produced plasmas. The so-called laboratory astrophysics allows one to access the miniature universe.

"In space plasmas, the key players sometimes hide in the small scale. It is very difficult to see their actions in large-scale space phenomena, even via cutting-edge [numerical simulations](#)," study author Toseo Moritaka explains. "Now laser experiments can arrange a new stage to shed light on their actions. The results will bridge various observations and simulations in macroscopic and microscopic points of view."

By using collective Thomson scattering measurements, the pure electron outflow associated with the electron-scale [magnetic reconnection](#) has been measured in laser produced plasmas for the first time.

"The outcomes of this research are applicable not only to space and astrophysical plasmas, but also to magnetic propulsion of spacecrafts and also fusion plasmas," study lead author Yasuhiro Kuramitsu explains.

"Microscopic electron dynamics governs macroscopic phenomena, such as magnetic reconnections and collisionless shocks. This is a unique and universal property of plasma, which is not seen in ordinary gas and liquid. Now we can address this in laboratories by direct local measurements of the plasma and [magnetic field](#). We will tackle long-standing open problems in the universe by modeling them in laboratories. Knowing the nature of plasmas may lead us to realize, for example, fusion plasma."

**More information:** K. Sakai et al, Direct observations of pure electron outflow in magnetic reconnection, *Scientific Reports* (2022). [DOI: 10.1038/s41598-022-14582-3](#)

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