X-Ray Fireworks Linked to Fast Radio Bursts

Predictions indicate that when a neutron star radiates a burst of radio waves, interactions of the burst with the star's magnetic field should produce observable x rays.

By **Sophia Chen**

For more than a decade, astronomers have been puzzling over observations of milliseconds-long radio signals called fast radio bursts. In recent years, research has suggested that these bursts might come from magnetars, a type of neutron star with a magnetic field about a thousand trillion times stronger than Earth's. However, the mechanism by which magnetars produce fast radio bursts remains unclear. Now, Andrei Beloborodov of Columbia University has theoretically investigated the interaction between a radio burst's strong electromagnetic waves and the magnetized particles around a magnetar [1]. He found that the radio waves scatter off the particles more strongly than previously thought, which could inform models looking to constrain the origin and location of fast radio bursts.

In the region of space immediately surrounding a magnetar, a fast radio burst can be modeled as an electromagnetic wave immersed in a magnetic field. When the strength of the magnetic field is much larger than the amplitude of the radio wave—as is the case close to a magnetar's surface—the wave is predicted to be minimally scattered by the plasma. But this condition no longer applies once the radio burst propagates some distance from the magnetar. Instead, the amplitude of the wave becomes much larger than the magnetic field.

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In that regime, Beloborodov found that the electromagnetic wave undergoes strong scattering. This scattering can inhibit the radio burst's escape, as it causes the wave to drastically lose energy. Wave scattering also generates large quantities of electron-positron pairs that then get accelerated by the electromagnetic waves. This process causes the pairs to emit x-ray "fireworks." Astronomers could potentially observe these fireworks to constrain models of fast radio bursts.

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REFERENCES

1. A. M. Beloborodov, "Scattering of ultrastrong electromagnetic waves by magnetized particles," **Phys. Rev. Lett. 128, 255003 (2022).**