INSIGHT INTO SOLAR FLARE MECHANISMS

A new study led by SwRI links quasi-periodic pulsations (QPPs) in solar flares to dynamic oscillations in magnetic reconnection, phenomena that can drive space weather and affect technology on Earth. This research could help refine traditional solar flare models and provide new insights into the mechanisms driving them.

Magnetic reconnection occurs when magnetic field lines in plasma break and reconnect, releasing immense energy into the surrounding atmosphere that can result in space weather. Solar flares are intense, transient bursts of energy on the Sun's surface and are the most common and spectacular examples of solar weather. QPPs, oscillating signals emitted across the electromagnetic spectrum, are often associated with solar flares. However, their origins and the functions driving them have eluded explanation.

"Solar flares are the largest eruptive phenomena in our solar system, but the mechanisms behind quasi-periodic pulsations have remained a mystery," said Dr. William Ashfield IV, postdoctoral researcher in SwRI's Solar System Science and Exploration Division. He is lead author of a Nature Astronomy paper describing new findings about these phenomena. "While QPPs appear in around 50% of large solar flares, they are still poorly understood. We wanted to get a better sense of why they occur and figure out how they fit into the energy release process."

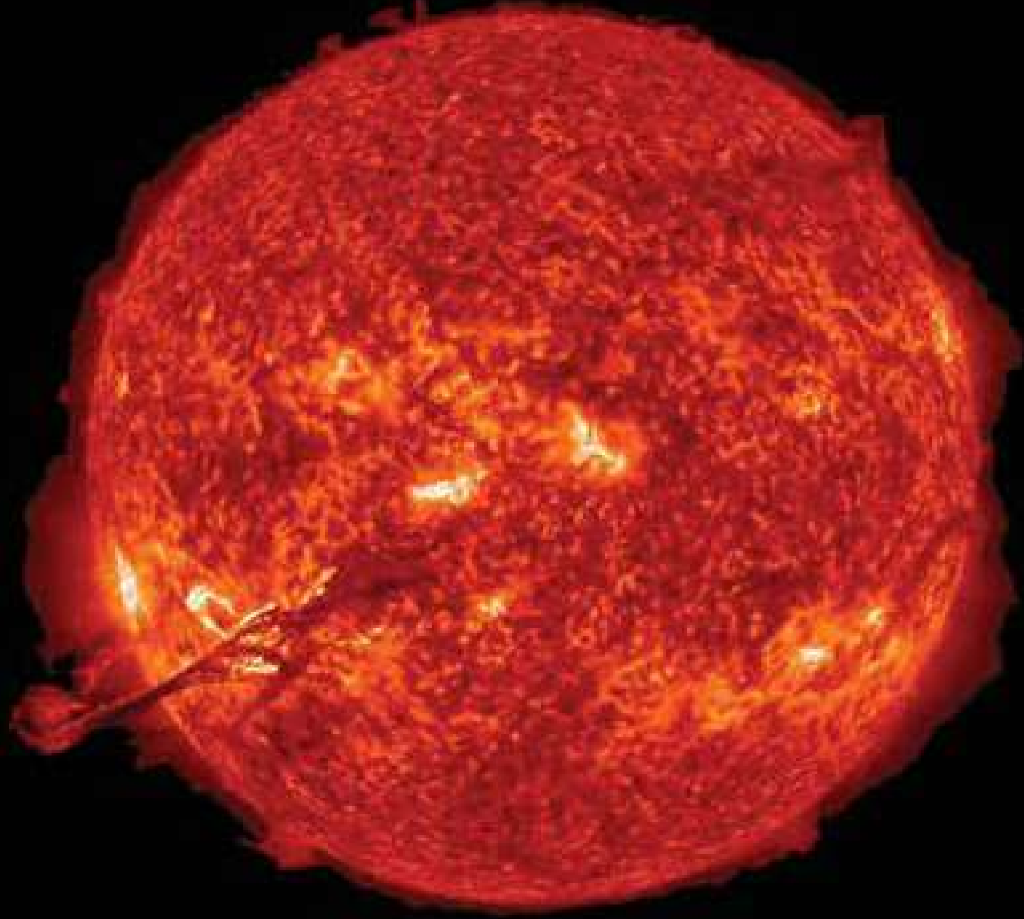
To better understand the nature of QPPs, the researchers used high-resolution observations from the Swedish Solar Telescope in the Canary Islands and precise spectroscopic data from NASA's IRIS telescope in Sun-synchronous orbit. The researchers observed a moderate-strength solar flare and conducted a pixel-by-pixel spectroscopic analysis to capture QPP evidence successfully.

"The complementary observations from ground-based and space-based telescopes allowed us to rule out competing theories and narrow down potential driving mechanisms behind QPPs," Ashfield said. "Our findings suggest that repeated magnetic reconnection may be what leads directly to the QPPs observed in this solar flare."

According to Ashfield, the study highlights the need to incorporate oscillatory behavior into magnetic reconnection theories, providing constraints to guide future research.

"Understanding QPPs isn't just about understanding the solar flares themselves," Ashfield said. "Our research lays a foundation for future studies to use larger datasets and advanced simulations to deepen our understanding of space weather events and other astrophysical phenomena associated with magnetic reconnection."

SwRI-led research suggests that repeated magnetic reconnection may be what leads directly to quasi-periodic pulsations observed in solar flares, such as this medium-sized flare, which sparked a long, magnetic filament to erupt.



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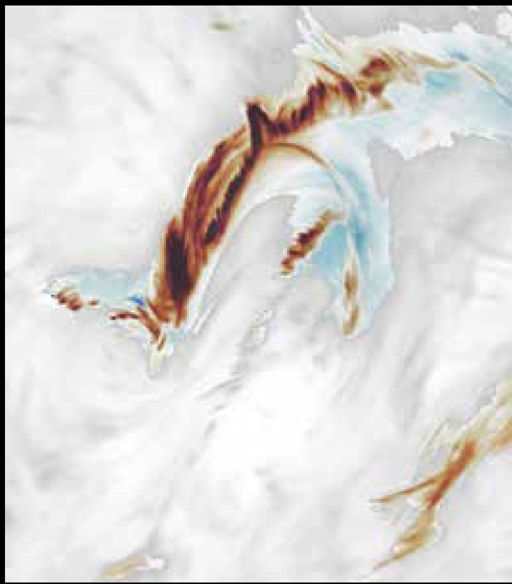

New SwRI-led research connects circular flare ribbons with energy released by repeated bursts of magnetic reconnection and quasi-periodic pulsations, finding plasma flowing downward (red) and upward (blue), respectively. Downward flows pulsed in time across the entire ribbon suggest that magnetic field lines breaking and reforming release tremendous amounts of energy that drive the entire flare.