Institute for Space Weather Sciences Colloquium

Thursday, 5th of December 2024, 1pm ET

meeting ID: 917 2169 7568, password: isws

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From Chromospheric Evaporation to Coronal Rain: An investigation of the mass and energy cycle of a flare

Chromospheric evaporation (CE) and coronal rain (CR) represent two crucial phenomena encompassing the circulation of mass and energy during solar flares. While CE marks the start of the hot inflow into the flaring loop, CR marks the end, indicating the outflow in the form of cool and dense condensations. With the Interface Region Imaging Spectrograph (IRIS) and the Atmospheric Imaging Assembly (AIA) on the Solar Dynamics Observatory, we examine and compare the evolution, dynamics, morphology, and energetics of the CR and CE during a C2.1 flare. The CE is directly observed in imaging and spectra in the Fe XXI line with IRIS and in the Fe XVIII line of AIA, with upward average total speeds of 138 ± 35 km s−1 and a temperature of 9.03 ± 3.28 × 106 K. An explosive-to-gentle CE transition is observed, with an apparent reduction in turbulence. From quiescent to gradual flare phase, the amount and density of CR increase by a factor of ≈4.4 and 6, respectively. The rain' s velocity increases by a factor of 1.4, in agreement with gas pressure drag. In contrast, the clump width variation is negligible. The location and morphology of CE match closely those of the rain showers, with similar CE substructure to the rain strands, reflecting fundamental scales of mass and energy transport. We obtain a CR outflow mass three times larger than the CE inflow mass, suggesting the presence of unresolved CE, perhaps at higher temperatures. The CR energy corresponds to half that of the CE. These results suggest an essential role of CR in the mass–energy cycle of a flare.

Dr. Seray Şahin Solakcı received her Bachelor's in Space Science and Technologies and Physics at Akdeniz University, followed by a master's degree from the same university and same department. She then moved to the United Kingdom, where she received her PhD in solar physics from the Institute of Mathematics, Physics, and Electrical Engineering. During her PhD research, she investigated the connection between coronal rain and the hot corona using IRIS, SDO, and SST instruments. She also conducted solar observations with Goode Solar Telescope at the Big Bear Solar Observatory (BBSO) in 2018. She was selected as a young woman scientist in the International Space Science Institute (ISSI) project titled "What Solar Observations Can Teach Us about Multiphase Plasmas across Astrophysical Scales" in 2022- 2024. She also received two awards: one from the National Astronomy Meeting (in 2021) and another from the UKSP Early Career Researcher (in 2023) poster competition. Additionally, she was honored with the Metcalf Travel Award at the Hinode-15/IRIS-12 conference held in Prague.