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Two-scale model for energy release in solar flares

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Dissipation in collisional plasmas is described in terms of kinetic coefficients, such as the resistivity and the viscosity, that depend explicitly on a collision frequency. On a macro scale dissipation in collisionless plasmas often mimics that in collisional plasmas, allowing it to be described in terms of effective or `anomalous' kinetic coefficients. On a micro scale the effective dissipation processes involve various plasma instabilities and stochastic phenomena that combine to simulate the effect of collisions. A familiar example is for collisionless shocks, that satisfy the Rankine-Hugoniot relations on the macro scale, with the structure of the shock front reflecting the various micro processes involved.
It is argued that energy release in solar flares should be similarly viewed on two vastly different scales. On the macro scale magnetic reconnection between current-carrying loops allows the system to relax from a configuration with a higher magnetic energy to one with a lower magnetic energy, with the magnetic energy released powering the flare. On this scale the system may be described by MHD theory with effective kinetic coefficients included. On the micro scale dissipation is attributed to a large number of highly localized, anomalously resistive regions. A two-scale model is developed to link the effective dissipation on the macro scale to the network of micro scale dissipation regions. The micro scale regions are identified as localized magnetic nulls in a magnetically turbulent region, as suggested by Lazarian & Vishniac (1999). Particular emphasis is given to the coupling between the micro regions, which is attributed to Alfvenic-type disturbances.

References

[1] Lazarian, A., & Vishniac, E.T., 1999, ApJ, 517, 700