[구 HA-04] Effect of the density profile of a star on the bolometric light curve in tidal disruption events

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Tidal disruption events (TDEs) provide evidence for quiescent supermassive black holes (SMBHs) in the centers of inactive galaxies. TDEs occur when a star on a parabolic orbit approaches close enough to a SMBH to be disrupted by the tidal force of the SMBH. The subsequent super-Eddington accretion of stellar debris falling back to the SMBH produces a characteristic flare lasting several months. The theoretically expected bolometric light curve decays with time as proportional to $t^{-5/3}$. However, the light curves observed in most of the optical-UV TDEs deviate from the $t^{-5/3}$ decay rate especially at early time, while the light curves of some soft-X-ray TDEs are overall in good agreement with the $t^{-5/3}$ law. Therefore, it is required to construct the theoretical model for explaining these light curve variations consistently. In this paper, we revisit the mass fallback rates analytically and semi-analytically by taking account of the structure of the star, which is simply modeled by the polytrope. We find the relation between a polytropic index and the power law index of the mass fallback rate. We also discuss whether and how the decay curves, which we derived, fit the observed ones.

[구 HA-05] Simulating astrophysical shocks with a combined PIC MHD code

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Astrophysical shocks accelerate particles to high velocities, which we observe as cosmic rays. The acceleration process changes the nature of the shock because the particles interact with the local magnetic field, removing energy and potentially triggering instabilities.

In order to simulate this process, we need a computational method that can handle large scale structures while, at the same time, following the motion of individual particles. We achieve this by combining the grid magnetohydrodynamics (MHD) method with the particle-in-cell (PIC) approach. MHD can be used to simulate the thermal gas that forms the majority of the gas near the shock, while the PIC method allows us to model the interactions between the magnetic field and those particles that deviate from thermal equilibrium.

Using this code, we simulate shocks at various sonic and Alfvenic Mach numbers in order to determine how the behaviour of the shock and the particles depends on local conditions.

[구 HA-06] Enhanced spontaneous emissions from suprathermal populations in Kappa distributed plasmas

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The present study formulates the theory of spontaneously emitted electromagnetic fluctuations in magnetized plasmas containing particles with an anisotropic suparthermal (bi-Kappa) velocity distribution function. The formalism is general applying for an arbitrary wave vector orientation and wave polarization, and for any wave-frequency range. As specific applications, the high-frequency electromagnetic fluctuations emitted in the upper-hybrid and multiple harmonic electron cyclotron frequency range are evaluated. The fluctuations for low-frequency are also applied, which include the kinetic Alfvén, fast magnetosonic/whistler, kinetic slow mode, ion Bernstein cyclotron modes, and higher-order modes. The model predictions are confirmed by a comparison with particle-in-cell simulations. The study describes how energetic particles described by kappa velocity distribution functions influence the spectrum of high and low frequency fluctuations in magnetized plasmas. The new formalism provides quantitative analysis of naturally occurring electromagnetic fluctuations, and contribute to an understanding of the electromagnetic fluctuations observed in space plasmas, where kappa-distributed particles are ubiquitous.