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A theorist's expectation of CrossScale: A reconnection case

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CrossScale is the first mission to the magnetosphere that will perform simultaneous multi-scale measurements of space plasma dynamics. As being discussed among European and Japanase space plasma physists, it will consist of more than 10 spacecraft, which as a whole will cover three scales (electron, ion and MHD scales) of the dynamics. High-time resolution electron detection will also be made so that electron scale dynamics can be trully resolved. In this talk, we will show our recent results from numerical simulations of magnetic reconnection process and argue that, from the point of view of a theorist working on the issue, the simultaneous multi-scale observations are indeed what is required as the next step. While the full scale simulation is not possible, by combining in mind the results from different types of simulations of different scales (full particle, two-fluid and MHD), we are getting to see that there should be dynamical interaction among the scales when the full scale simulation is done and this would be the essential feature of the process. It is well known that the reconnection jet is an MHD-scale phenomena while the physics of its engine region is dominated by ion and electron scale dynamics, and thus multi-scale treatment is necessary to understand the reconnection process. Here we will step further and argue that in nature the coupling among the scales occurs in a temporally varying fashion. The implication is that the true understanding of the process does not come from a superpositioning of observations at different scales made at different times (e.g., Cluster+MMS). It comes only from SIMULTANEOUS multi-scale observations.