Project Title:
Kinetic properties of collisional plasmas

Project Reference Code:
UAH-Nakanotani

Host Facility:
The University of Alabama in Huntsville

Host Facility Location:
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Huntsville, AL 35899
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Project Description:
Collisionless plasma, in which Coulomb collisions between species can be neglected, has been intensively investigated by means of theories, simulations, observations, and experiments. In space plasma, the solar wind from the sun is a typical case of collisionless plasmas. The mean free path is about 1 astronomical unit (au), which corresponds to the distance from the sun to Earth. However, time and length scales observed by spacecraft are much less than the mean free path. It means that other mechanisms must work in the dynamics of the solar wind. In collisionless plasma, several wave modes play an essential role since particles interact via only waves. On the other hand, collisional plasma in space has been paid attention in recent years. The chromospheric plasma and the interstellar plasma are a typical case of collisional plasmas. Their temperature is relatively low and they include abundance of neutral atoms. In this case, collisions between species likely modify waves inside the plasmas.

Full particle-in-cell (PIC) simulation has been developed to investigate kinetic features of plasma. In this simulation, ions and electrons are treated as a super-particle to resolve the velocity distribution functions of the species. Therefore, this is a first-principle simulation for plasmas, which means there are no approximations made in describing the plasma. This allows us to produce from micro to macro scale physics in the simulation and in principle, every wave mode that is admitted by the plasma system.

The purpose of this project is for the student to understand how collisional effects modify kinetic properties of collisionless plasmas using state-of-the art open-source software of full PIC simulations implemented with collisional effects. S/he will derive linear wave modes in plasma including collisions between species and compare with the simulation results. If time permits, s/he will apply this simulation to investigate a plasma instability, such as the Buneman instability.

Disciplines:
Physics, Math, Computer Science, Space Science

Is U.S. citizenship required to participate in this project?
No

Internship Location and COVID-19 related Backup Plan
The internship location is the University of Alabama in Huntsville. Due to the COVID-19 pandemic, we are preparing multiple options to ensure that the internship will take place. We are looking at least at an in-person, hybrid, and fully virtual option. For any in-person component we will ensure that there is adequate physical spacing between workspaces, following all university cleaning protocols.

Name(s) of Mentor(s) and contact information:
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Internship Coordinator/ HR manager:
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The name and contact information of personnel at the host facility is provided for further assistance with questions regarding the host facility or the project.

Interns will not enter into an employee/employer relationship with the host facility. No commitment with regard to later employment is implied or should be inferred.