M2 INTERNSHIP PROPOSAL (March-July 2021)

Institution : Aix-Marseille université, CNRS

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Title: **Charging and transport of nanoparticles in collisional plasmas**

Abstract: Nanoparticles (NPs) can be synthetized in a large variety of plasmas for industrial applications extending from the field of nanomaterial/nanotechnology to the field of production/storage of energy. Their presence and more generally, the presence of dust can also be deleterious in plasma processes dedicated to film deposition as well as in tokamaks dedicated to fusion researches. In the latter case, dust particles which are produced by plasma-tokamak wall interaction decreases the expected performances by dispersing radiating impurities or by generating disruptions when they are deposited on the wall part receiving the largest particle fluxes

The goal of this internship is to improve the expression of the NP charging mechanism in collisional laboratory plasmas where ion-neutral charge exchange may be considered. In a second step, the forces applied to NPs will be found numerically: the electric force, the collection and Coulomb ion drag forces and the thermophoretic force. The resulting force will inform on the location where nanoparticles are grown in the plasma and where they can be collected in the plasma device.

Preliminary researches were dedicated to the study of the NP growth in laboratory magnetized plasmas produced between two parallel electrodes, this giving approaches to the NP formation in the tokamak coldest regions. Discharges are produced in argon gas at high pressure in order to favor particle collisions. The sputtering of tungsten (W) cathodes by argon ions accelerated in the cathode sheath allows to inject continuously W atoms in the plasma. Their cooling by collisions with the discharge gas and their mutual collisions leads to the formation of W-clusters, which grow until the appearance of NPs [1]. During these mechanisms, two-dimension spatial (2D) measurements of the plasma density and temperature were already obtained using Langmuir probes [2] as well as the 2D variation of the gas temperature using optical diagnostics. These data will be used by the applicant to find numerically the 2D variation of the NP charge and applied forces.

References:

[1] C. Arnas, A. Chami, L. Couedel, T. Acsente, M. Cabié, T. Neisius, *Thermal balance of tungsten monocrystalline nanoparticles in high pressure magnetron discharges,* Physics of Plasmas **26**, 053706 (2019)

[2] A. Chami and C.Arnas, *Spatial distributions of plasma parameters in conventional magnetron discharges in presence of nanoparticles*, J. Plasma Phys. **86**, 905860512 (2020)