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Activity title: Super-Intense Laser-Matter Interactions (SILMI)

Title of the proposed research project: Frontiers of Plasma Physics - Analytic and Numerical Approaches in the Kinetic Description of Ultra-Intense Laser-Matter Interactions

Scientific report on a visit in the framework of the Short Visit grant 3638

The Division of Laser Plasma at the Institute of Plasma Physics and Laser Microfusion is seeking to expand its capabilities in the theoretical approaches to kinetic description of the relativistic laser-plasma interactions, with applications to the laser-driven ion acceleration and related processes. To this end I was sent to visit the International Centre of Theoretical Physics in Trieste in the period July 4 - July 17 2010, in order to attend the International Advanced Workshop on the Frontiers of Plasma Physics that was taking place there at that time. My task was to tap the expertise of the top specialists in the laser-plasma interactions and establish new scientific contacts that would be helpful for my home institution.

During the workshop first of all I met with Prof. Francesco Pegoraro from the University of Pisa, who is a top theorist in the field of laser plasma physics and whose research interests strongly overlap with the activities of the IPPLM group. We discussed three topics: (a) the problem of Hamiltonian formulation of the collisionless plasma dynamics and possible formulation of variational principles that might offer alternative way for a numerical solution of plasmic dynamics; (b) the problem of numerical schemes for solving the Vlasov-Maxwell equations for the laser-plasma interactions; (c) the problem of analytic description of the ion acceleration in the thin-foil approximation, where the dominating effect is the radiation pressure (the so called light-sail model). Discussions with Prof. Pegoraro helped me improve a semi-analytic model of the laser-plasma interactions that I am working on and make some adjustments in my approach to solve numerically the Vlasov-Maxwell equations, which would be reported in a forthcoming publication. It was decided that we would stay in contact concerning more detailed aspects of our work and further joint efforts. We agreed to continue our discussion when we meet at the forthcoming conference "Superstrong Fields in Plasmas" in Varenna in October this year.

During the workshop I also had the opportunity for productive discussions with several other scientists:

- a) Prof. B. Eliasson (Ruhr-Universität Bochum) - technical aspects of the numerical Vlasov-Maxwell codes;
- b) Prof. R. Bingham (Rutherford Appleton Lab.) - production of elementary particles in the interactions of ultra-intense laser beams with solid targets;

c) Prof. N. Shatashvili (Tbilisi State University) and Prof. S. Mahajan (University of Texas in Austin) - laser-induced electron-positron production and the behaviour of the electron-positron plasmas;

d) Prof. K. Mima (Institute of Laser Engineering, Osaka University) - models for hot electron generation in the ultra-intense laser-solid interactions, with applications to the fast ignition;

e) Prof. T. Ditmire (University of Texas in Austin) - use of laser-generated proton beams in the studies of high energy density states.

The local host for the workshop was Prof. J. Niemela, who is in charge of the Optics and Laser Physics Laboratory at ICTP. The research at the laboratory is concentrated on physics and applications of the short pulse lasers, but it is also involved in the operation of a free electron laser located in Trieste. We discussed prospects for collaboration between laser groups at ICTP and IPPLM. There is a possibility that ICTP might be interested in a scheme which would allow ICTP Associates to work with the 10 TW short pulse laser at the IPPLM in Warsaw.

Overall, my stay in Trieste was extremely productive, and I am very grateful to SILMI for offering a support which made this visit possible.