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Age factor for Physicists?

A person who has not made his great contribution to science before the age of thirty will never do so....

(Einstein)

Age is, of course, a fever chill, that every physicists must fear.

He's better dead than living still, When once he's past his thirtieth year!

(Dirac)

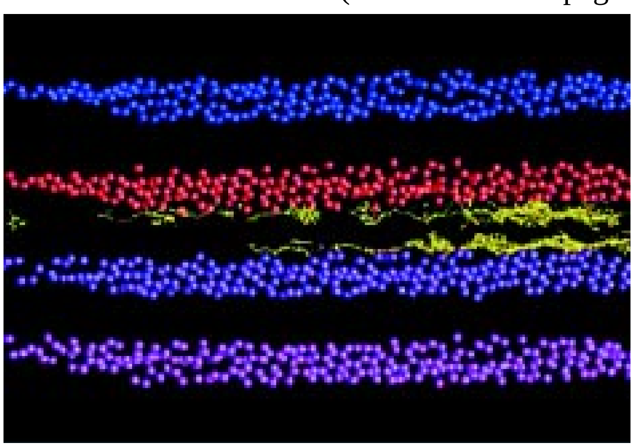
Congratulations!!

PSSI congratulates Professor P. K. Kaw, Director (IPR) to receive an honor of R.D. Birla award for Excellence in Physics-2002 for his outstanding contributions to Physics.

PSSI also congratulates Dr. V. Selvarajan. Professor, Department of Physics, Bharathiar University, Coimbatore to receive an honor of Tamilnadu Scientist Award 2002 by Tamilnadu State Council for Science and Technology, Chennai, and wish him for many more such achievements.

MOLUCULAR DYNAMICS IN FUSION RESEARCH

(See for detail on page-3)



Htrajectory in a Graphite crystal

By Shishir Deshpande (IPR)

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IPR-TIFR Collaboration on Laser-Plasma Interaction

High intensity (~10^{15} - 10^{16} W/cm^2), short laser pulses (~100 fs) have opened up a new regime in laser-plasma interaction experiments. It is a regime, in which light is deposited into a solid surface faster than the surface can hydrodynamically expand, resulting in the formation of a small scale length ($L/l \ll 1$) plasma. Experiments with such small scale length plasmas are relatively clean in the sense that they do not support the usual parametric instabilities found in *nsec* laser-plasma interaction experiments.

Understanding the physics of ultra-short laser pulses interacting with short scale length plasmas is important both from the viewpoint of fundamental science as well as from the viewpoint of practical applications like fast ignitor concept in ICF, production of pulsed X-rays, measurement of equation of state of materials in the high pressure regime, extreme ultraviolet lithography, design of table-top acclerators etc. With the purpose of understanding the fundamental issues behind ultra-short laser pulse-plasma interaction, a IPR-TIFR collaboration was set up about two years back.

One of the projects in which this collaboration has recently achieved considerable success is, in the generation and measurement of, one of the largest terrestrial magnetic fields (~ 27 MG) of ultrashort duration (~ 6ps). Measurement, PIC simulations and phenomenological modeling of the rise and decay of these pulsed magnetic fields, has provided the first direct experimental observation of turbulence induced anomalous resistivity. Such high magnetic fields are generated by a combination of currents *viz.*, direct hot electron current generated by the incident laser and the return shielding current generated in response to the hot electron current. Further 2-dimensional fluid simulations of these current channels (direct hot electron current + return shielding current) have shown these channels to be unstable towards sausage/kink mode, thus pointing towards the mechanism of anomalous stopping. This anomalously rapid damping of the return plasma shielding currents produced in response to the hot electron currents generated by the incident laser pulse, is a topic of considerable significance to the fast ignition scheme of laser fusion. Futher experiments aiming for a comparative study of the propagation of hot electrons through dielectrics and conductors are currently on at TIFR.

Besides measurements and analysis on pulsed magnetic fields, IPR-TIFR collaboration has also looked into issues related to mechanism of absorption of laser light by sharp (small L/l) targets. One of the problems which was addressed both experimentally and theoretically, is the absorption of laser light by rough metallic targets. This study is motivated by the fact that, in the final stages of laser fusion, when the fast ignitor pulse hits the pre-compressed target, it actually sees a modulated target surface, the modulation being generated by Ritchmeyer-Meshkov type of instability. Experiments done at TIFR, by systematically varying the roughness of a target, have shown that rough (unpolished) targets produce much hotter electrons as compared to polished targets regardless of the incident polarization. Production of hotter electrons is an indication of higher absorption. The explanation of higher absorption by rough targets lies in the excitation of surface waves. The absorption of laser light by a sinusoidally modulated metallic surface was numerically evaluated and shown to be higher than that of a plane target. Further experiments on surface waves using ruled gratings as targets are being planned at TIFR.

In conclusion, in the last two years, the collaboration between IPR and TIFR has reached a very mature stage and it is expected to grow further in the years to come.

(Ref: A.S.Sandhu et al., *Phys. Rev. Lett.*, 89 (2002) 225002)

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Molecular dynamics: Current applications in fusion research

ITER is the next step toward the final aim of using fusion as a clean, unending source of energy. It is designed based on current knowledge from the various operating scenarios of tokamaks and extrapolation thereof of various operating parameters. One of the main challenges of ITER design is the plasma facing material (PFM)[1]. Graphite and carbon fiber composites (CFCs) are the most widely used PFMs in the run-up to ITER. However in a reactor like scenario these materials show problems like recovering co-deposited tritium and possible formation of explosive dust. There also remains a lack of understanding on the extrapolation of chemical sputtering yields to higher incident particle fluxes and in the hydrogen isotope inventory and recycling in a steady state conditions. In order to shed light on the above uncertainties, a microscopic level study of the various chemical reactions, the various trapping and detrapping mechanisms, the effect of the porous structure of graphite, the H isotope diffusionin the crystallites and micro-voids of graphite is essential. Such knowledge can also drive materials research toward new types of graphite more suitable for fusion reactors.

The most intuitive method to study microscopically the motion of atoms and their interactions amongst themselves is to solve the N body force equation in terms of inter-particle potential, F Molecular dynamics (MD) aims to do exactly just this using a computer since even for very small N or for complicated forms of F , the above problem is not analytically solvable. The heart of the problem is the inter-particle potential F term. The quality of the results one gets from MD is only as good as the F one uses. Quantum mechanical approximations (density functional theory, tight binding, etc) are used to first find the Phi. However this limits N to at most 100 with the best computers available. As far as the carbon-hydrogen system is concerned, D. Brenner constructed an empirical Phi [2] which reproduces hydrocarbon formation and can be used to study hydrogen isotope interaction with graphite. K. Nordlund extended the Brenner potential [3] to include long range interactions so that the hydrogen interaction with crystal graphite could also be studied. Using an empirical potential allows one to model thousands of particles. This coupled with various computational techniques help solve the above MD problem. These include introduction of appropriate boundary conditions (for example, periodic boundary conditions to extend the studied sample appropriately), maintaining the right temperature or/and the right pressure in the system, including speeding up techniques in the force calculation depending on the Phi profiles (long range / short range), etc. For a introductory tutorial on these methods check out Furio Ercolessi's page http://www.fisica.uniud.it/~ercolessi/md and for a more detailed study check out Kai Nordlund's lecture notes at http://www.acclab.helsinki.fi/~knordlun/atomistiset. Figure on the cover page shows the trajectory (yellow) of a single H interstitial diffusing in between 2 graphene layers (different colors) of crystal graphite.

Some examples of the application of MD to fusion research include (i) Study of surface sputtering (called swift chemical sputtering) of co-deposited hydrocarbons [4]. (ii) Study of the effect of high incident particle flux on chemical sputtering [5]. (iii) Hydrogen reflection studies on amorphous C-H surfaces [6]. (iv) Modeling the diffusion of hydrogen in porous graphite [7].

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Understanding Research Papers..........

THEY WRITE	*THEY MEAN*
❑ While it has not been possible...	The experiments didn't work out.
❑ to provide definite answers to these questions...	but I figured I could at least get a publication out of it....
❑ Typical results are shown...	The best results are shown...
❑ Although some detail has been lost in reproduction, it is clear from the original micrograph...	It is impossible to tell from the micrograph...
❑ The agreement with the predicted curve is:	
excellent	fair
good	poor
satisfactory	doubtful
fair	imaginary
as good as could be expected	non-existent
❑ It is clear that much additional work will be required before a complete understanding...	I don't understand it...
❑ Unfortunately, a quantitative theory to account for these effects has not been formulated.	...neither does anybody else.
❑ Correct within an order of magnitude.	Wrong.
❑ It is hoped that this work will stimulate further work in the field.	This paper isn't very good but neither are any of the others on this miserable subject.
❑ Thanks are due to Joe Glotz for assistance with the experiments and to John Doe for valuable discussions.	Glotz did the work and Doe explained what it meant..