ABSTRACTS

Spectral Lines in Plasmas, Yu. Ralchenko
Most of information on properties and evolution of plasmas, from fusion devices and solar corona to EUV light sources for lithography to dense laser-produced plasmas, comes from analysis of their spectra. Whereas the continuum (free-free and free-bound) emission may at times be useful for diagnostics, it is primarily the spectral lines originating from transitions between bound states that deliver the bulk of data on diverse parameters such as plasma density and temperature, electromagnetic fields, and particle energy distributions, to name a few. This lecture will address the current understanding of physical processes responsible for line emission in plasmas as well as outline the typical strategies for spectroscopic plasma diagnostics in various environments.

Spectral lineshape modeling state of art, A. Calisti
Spectroscopic measurement of the line transitions is one of the richest sources of diagnostic information about plasma properties. The diagnostic is then based on the comparison of observed and modeled spectra for partially puzzling out hidden information. Evidently, to be reliable, this requires accurate theoretical models of atomic and radiation physics.
This lecture will cover:

- The importance and role of spectral line profiles in the diagnosis of plasma properties, the formation of opacity and the radiation transport.
- The theoretical formulation for spectral line profiles illustrating first, the concept of separation of ion and electron broadening mechanisms and the formation of spectral lines, and second, the additional mechanisms such as Doppler Broadening, magnetic field effects and instrumental broadening affecting the line shape.
- Illustration by examples of spectroscopic diagnostics in laser-plasma, inertial fusion and Tokamak experiments.

Population Kinetics Modeling For Plasma Spectroscopic Analysis, H. K. Chung
- General description of population kinetics modelling
- Demonstration of FLYCHK simulations for various plasma studies.

The goal is to provide basic understanding of atomic processes in plasmas and population kinetics modelling used for plasma spectroscopic analysis. The lecture will provide details on how to build a population kinetics model and demonstrate how to use a generalized population kinetics code FLYCHK available at
http://nlte.nist.gov/FLY/
for laser-produced plasmas, photo-ionized plasmas, radiative loss rates, two temperature plasmas and so on.

An introduction to the interaction of X-ray free electron laser radiation with matter, F. Rosmej
The lecture provides an introduction to the physics of the interaction of X-ray Free Electron Laser (XFEL) radiation with matter. Unlike optical lasers, where energy absorption is essentially realized by inverse Bremsstrahlung and parametric instabilities, the primary absorption mechanism of XFEL is photoionization of atomic shells. Due to the large photon energy (up to 20 keV), XFEL radiation photoionizes mainly inner atomic shells thereby creating very exotic states [1,2]: hollow atoms/ions, hollow crystals. The atomic physics processes related to these exotic states are essential to understand XFEL interaction with matter and the temporal evolution from a solid to Warm Dense Matter (WDM).

Astrophysical X-ray spectra, J. Kaastra
The various way X-ray spectra of astrophysical sources are being measured and formed under different astrophysical conditions, ranging from collisional equilibrium, photoionisation equilibrium and non-equilibrium ionisation conditions. I will give an overview of the relevant processes that play a role under these conditions, and their link

to the basic atomic processes. I will also show some example spectra for the various cases.

Can we nurse the fire? The physics of magnetic fusion, D. Reiter

With the first net power producing fusion plant ITER now being under construction, in a worldwide collaborative effort, controlled nuclear fusion research ushers in a new era. For the first time a controlled thermonuclear burning fire is expected to be ignited on earth. In this tokamak ITER in Cadarache (France) in about a decade from now, plasmas with a fusion power of 500 MW at an external heating power of 50 MW can be magnetically confined.

According to current knowledge, which is based on extrapolation from a huge experimental and theoretical basis build up over half a century, the ignition of a plasma flame in a tokamak magnetic confinement devise of the scale of ITER seems secured. But new challenges arise on the next step from ignition towards maintaining the plasma flame, continuous duty, in equilibrium also with the walls of the furnace chamber, under nuclear conditions. These issues are not yet solved.

The major magnetic confinements concepts in controlled fusion research: tokamaks and stellarators, will be introduced, their pros and cons, and their status of development relative to the requirements of a first power plant targeted for the middle of the present century.

The role of atomic processes in such thermonuclear burning hydrogenic plasmas will briefly be introduced. This will be covering the range from hot plasma physics (all chemical bonds broken) for core plasma diagnostic (plasma spectroscopy) up to the chemically rich plasma boundary near the walls, the latter with processes in energy ranges partially overlapping with those in (technical) low temperature plasma or astrophysical plasma (stellar and planetary atmospheres) applications.