PROGRAMMA SHORT TERM MOBILITY – ANNO 2010

***Proponente*: Roberto Flammini**

***Fruitore*: Roberto Flammini**

***Istituto di afferenza del Fruitore*: ISTITUTO DI METODOLOGIE INORGANICHE E PLASMI**

***Istituzione ospitante*: SOLEIL, SYNCHROTRON RADIATION SOURCE, St. Aubin, FRANCE**

***Titolo del programma*: Study of nanobio-aggregates by electron and electron-ion coincidence spectroscopies**

Final Report:
1) brief description of the experimental set-up

SOLEIL is an optimized 3rd generation 2.75 GeV synchrotron light source of which construction was recently finalized in the South of Paris (Saint-Aubin). A permanent staff of 350 people organized as the Experimental, Source and Accelerators Divisions, Technical, Computer Support and Administration Divisions operate the installation for users and in-house research.

PLEIADES is a soft X-ray beamline, which went into operation in 2009 and welcomed its first users from March 2010. Dedicated to spectroscopic studies of dilute samples (atoms, molecules, ions, clusters, nanoparticles and large biological molecules), PLEIADES is a multi-topics beamline (relaxation dynamics, vector correlations, multiple photoionization, photochemistry, radiation damage…) designed to deliver to the users a highly monochromatic photon beam (energy between 7 and 1000 eV), with any type of polarization (linear, circular, elliptical). Several experimental stations are permanently installed on the beamline offering the users and the beamline scientific team a wide panel of top-level techniques. Moreover, the beamline is able to accommodate specific experimental setups of the external users.

The large amount of spectroscopic techniques available (absorption, threshold electron, photoelectron and Auger electron spectroscopies, ion mass spectrometry, as well as fluorescence spectroscopy etc.) and the extensive use of the coincidence techniques are based on a wide range of state of the art spectrometers and detectors. The dilute samples available for study are produced either through effusive or supersonic molecular beams or by an ion source.

The novelty at PLEIADES beamline is the simultaneous use of the most advanced technologies for both beamline (Ex: the use of original VLS/VGD gratings for the PGM, leading to the possibility of using a resolving power of about 50000 near the O K-edge) and the available spectrometers (VG Scienta – R4000 electron spectrometer and efficient Auger electron–ion coincidence experiment based on the use of a “Double Toroidal” electron analyzer). The first results obtained in 2009 show exceptional performances in terms of spectral resolution, flux and polarization state, allowing for new investigation fields

to be addressed.

2) brief description of the activity during the STM program:

It has been shown that soft X-ray spectroscopies at very high resolution (photoelectron, Auger or electron – ion coincidence spectroscopies) in the so called sub-lifetime regime represent a very reliable alternative to the use of the recently developed fully time-resolved techniques (Ex: short pulses obtained by HHG in rare gases) for the study of the very fast dynamics of the core-excited species (fs). RAS (resonant Auger spectroscopy) is the main tool to investigate the time-dependance of decay processes.

During this beamtime, the Resonant Auger Spectroscopy (RAS) has been used for the first time to study the decay process in ammonia clusters. RAS was already been used to study molecular ammonia, to elucidate the phenomenon called “ultrafast fragmentation”. This particular effect was discovered 25 years ago in the HBr molecule: when the Bromine atom is excited to the first unoccupied level, the molecule undergoes a fragmentation *before* the Auger decay, so that the Auger electron has an *atomic* instead of a molecular, character. The Auger decay is estimated to occur in the femtosecond time-scale, so that the fragmentation may occur in hundreds of attoseconds.

One of the results, which will be object of publication, shows that the phenomenon of the ultrafast fragmentation seems not to be present when ammonia molecules are arranged in clusters. The suppression of the ultrafast fragmentation in clusters was observed already in methyl bromine and it is still a matter of debate.

During the same period spent at the Pleiades beamline, measurements on the $C_2H_2Br_2$ and C_2H_2ClBr have been also performed. Both the molecules are known and well characterised by Auger spectroscopy, XPS, PES and NEXAFS spectroscopies. Again, the topic of the “ultrafast fragmentation” has been addressed. Halogen containing molecules are known to undergo an ultrafast fragmentation. A complete series of measurements of the Resonant Auger electrons at the three (carbon, bromine and chlorine) edges have been performed. The results show that both the molecules undergo a fast fragmentation, either at the bromine or at the chlorine thresholds (and not at the carbon threshold). The possibility of formation of HCl or HBr molecules is currently under investigation.

The results will be object of publication on refereed journals.