Report of IUPAP Commission C15:
Atomic, Molecular, and Optical Physics (2005-2008)

to the

IUPAP Council and Commission Chairs Meeting
October 13 – 14, 2008, Tsukuba, Japan

Activities of the Commission

One of the major tasks accomplished by the commission C15 during the reporting period was the establishment and inauguration of the new IUPAP Young Scientist Prize in Atomic, Molecular, and Optical (AMO) Physics. Following the guidelines approved by the General Assembly at its Cape Town meeting in 2005 the officers of the commission developed a charter for the IUPAP Young Scientist Prize (YSP) in the spring of 2006 which was endorsed by the commission at its meeting in Innsbruck, July 20, 2006.
The stipulations are as follows:

- Eligible candidates have up to 8 years of research following their PhD not counting times of interruption of professional activities
- The prize will be awarded annually alternating between the two major "flagship" conferences regularly supported by IUPAP, the International Conference on Atomic Physics in even years and the International Conference on Photonic, Electronic, and Atomic Collisions in odd years
- The prize selection committee consists of the officers of the commission, two additional commission members, and one representative of the conference at which the award will be presented
- The prize consists of a medal, $ 1000 and the selection for an invited talk at the conference.
- All commission members will be given the opportunity to comment on the merit of the nominations.
- The local organizers are expected to support the conference participation of the prize winner, e.g. by waiving the conference fee.
- Nominations should clearly identify the nominee´s leading role in and contribution to the research to be recognized. Self-nominations will not be accepted.

This charter was approved by the IUPAP General Council at its meeting in Prague, Czech Republic, October 14, 2006. The first call for nominations was issued in November 2006 with deadline February 1, 2007. The first two prizes were awarded as follows:

- IUPAP-YSP in AMO Physics 2007: Robin Santra, Argonne National Laboratory (USA)
  " in recognition for his pioneering theoretical contributions in the field of atomic, molecular, and optical physics, in particular to the phenomenon of interatomic Coulombic decay"

- IUPAP-YSP in AMO Physics 2008: Chen Ching, University of Chicago, USA
  "in recognition for his pioneering contributions to the manipulation of ultracold quantum gases, in particular to the first molecular Bose-Einstein condensate"

The commission considers the prize and its reception by the AMO community a considerable success. One sign of recognition is the large number of outstanding nominations from a large number of countries. For example, for the 2008 edition we considered 18 nominations from 11 different countries.

During the period 2005-2008 the commission held three annual meetings:

- Innsbruck, Austria, July 20, 2006
- Freiburg, Germany, July 27, 2007
- Storrs, USA, July 29, 2008

The commission meetings were all well attended. One recurring theme of discussion were the visa and travel restriction problems scientists (including commission members) experience when attending international meetings. Of concern are not only outright rejections of visa applications, one recent case of which prevented a post-doc of Senegalese nationality employed at the Free University Berlin from attending ICAP in Storrs, USA, but the increasingly high administrative and financial hurdles created by visa application and admission requirements which may have a deterring effect on international exchange and participation in international conferences. .

The commission is very satisfied with the progress in the field of atomic, molecular and optical physics. AMO physics has made great strides despite the overall unsatisfactory funding situation and a multitude of career obstacles young scientists face in many countries. The latter is aggravated for female scientists who continue to be under-represented. Clearly, these negative trends are not specific to AMO physics and should be addressed in a broader context.

Scientific Highlights

In view of the many spectacular advances, it is not easy to single out individual highlights. Dramatic progress has been made, for example, in the field of "ultracold" atomic dynamics. Unprecedented control has been achieved in positioning, localizing, and moving atoms opening up novel scientific and technological avenues ranging from fundamental quantum physics, ultra-precise atomic clocks to quantum information processing. One highlight in this field was undoubtedly the first realization of the elusive Efimov states, a bound-state of three particles which do not form two-particle bound states. Such a true "quantum" bound state defying classical intuition have been predicted almost 40 years ago and could only now be realized with cold atoms with carefully tuned interactions [1].

Another topic where spectacular breakthroughs have occurred is the development and usage of novel light sources for investigation of atomic and molecular structure and dynamics. Along the direction of unprecedented brilliance, sources of VUV and X-ray radiation based on the principle of free-electron laser have become available at the FLASH (and later X-ray) facility in Hamburg, the XFEL facility in Japan, and LCLS at Stanford, USA, which are now on-line or about to go into operation. They offer, among many other opportunities, the perspective of imaging in real time complex molecules by X-ray absorption and diffraction on the femtosecond scale. Such tools hold the promise of an entirely new look at many systems ranging from simple molecule to biologically relevant systems [2,3]. Equally exciting are the advances in the quest for even shorter light pulses and their usage to uncover atomic dynamics on the time scale of electric motion. Non-linear interaction of single-cycle infrared pulses with atoms can generate ultrashort pulses in the VUV and XUV spectral regions with the record for shortest durations of well below 100 attoseconds [4]. Such pulse durations are becoming comparable to the characteristic time scale of the electronic motion in atoms. It is

thus now possible to " take snapshots" of the electrons moving inside atoms or forming molecular bonds. Along similar lines, the high-harmonic radiation resulting from the non-linear interaction has made possible the approximate tomographic imaging of molecular orbitals. The exploration of these new tools is still in its infancy and will likely yield exciting breakthroughs in the near future.

[1] H.C. Nägele et al. AIP, Conference Proceedings 869, 163 (2006), [Proc. XX ICAP, Innsbruck, Austria, 2006] and refs. therein
[2] J. Costello, J. Physics Conference Series 88, 012057 (2007), [Proceedings, XXV ICPEAC, Freiburg, Germany, 2007] and refs. therein
[3] L. di Mauro et al., J. Physics Conference Series 88, 012056 (2007), [Proceedings, XXV ICPEAC Freiburg, Germany, 2007] and refs. therein
[4] E. Goulielmakis et al., Science 320, 1614 (2008)