Electron capture by low velocity highly charged ions
A tribute to Michel Barat

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Synopsis Michel Barat passed away last November at the age of 80. We briefly review his contributions in the early days of highly charged ions before addressing atomic collisions at surfaces and inelastic diffraction.

One of us started his PHD by constructing the setup that Michel had imagined. A 2D position sensitive detector in the focal plane of an electrostatic analyser [1]. Such detector was not available but taking a proposal from D de Bruijn, FOM Amsterdam, we built it and were able to record, at once, the energy and angular scattering profile in coincidence with recoil ions and emitted photons (UV and Xrays). We were ready to do physics with these weird ions *e.g.*O^{8+}.

In what sense is the captured electron rotating ? With NO Andersen we could show that the captured electron tends to rotate along the intuitive direction [2]; A runner trying to jump into a merry go round will find which way to go. However this should not hold in the molecular regime where the electron motion is much faster that of the nuclei. The effect was calculated by A Dubois *et al* and VN Ostrovsky designed an elegant text-book molecular model.

Why do we observe higher n value? The selective electron capture into a given n shell was well explained by the coulombic barrier model but evidence for higher n capture were reported. Michel could interpret the population of higher n values by transitions at inner crossings[3] predicted by the Barat-Lichten-Fano electron promotion model.

Are the electrons captured simultaneously or one after the other?

We observed both situations [4] and we reformulated the question differently. What is the driving mechanism in simultaneous double electron capture ? With V Sidis, we showed that double electron capture can be explained[5] by a second order effect without the need of di-electronic interaction. The same mechanism was found responsible for other two electron process such as Transfer-Excitation.

How do two highly excited electrons manage to avoid autoionisation? The data indicated an initial population of quasi symmetric doubly excited states *e.g.* O^{6+}*(4l,4l')* [6] way above several ionisation limits and predicted to be auto-ionising. We showed that a significant part of the *(4l,4l')* population transfers to the straddling by di-electronic interaction and calculate the effect with H Bachau.

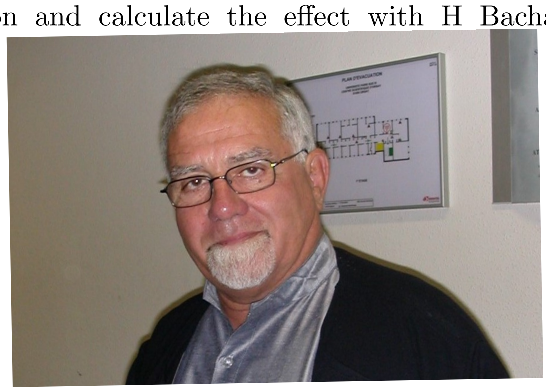

Figure . Michel Barat played a key role to promote the physics of atomic and molecular collisions.

With AK Kazansky [7] we showed that the electric field of the receding target transforms these linear Rydberg into circular Rydberg states where both electron orbits do not overlap anymore. With S Martin we identified the population of long-lived triply excited double Rydberg.

In less than ten years Michel *et al* published more than 40 papers, always with great enthusiasm. The second part will be devoted to inelastic grazing collisions of keV atoms at surfaces [8].

References

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