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## Oscillatory behavior of the valence photoionization properties of $N_2$ and $O_2$ due to coherent photoelectron emission from two sites

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**Synopsis** Coherent two-center photoelectron emission has been predicted for all electron subshells. So far, however, it has been only proven for the innermost 1s-subshell only. We present first results for the valence photoionization of  $N_2$  and  $O_2$  showing oscillatory behavior in both, the partial cross section  $\sigma$  and the angular distribution asymmetry parameter  $\beta$ .

New Synchrotron Radiation sources such as the "Variable Polarization XUV beamline P04" at PETRA III (DESY, Hamburg) which is presently under construction enable new classes of photoionization experiments. The main characteristics of these beamlines are exceptionally high resolution which well exceeds a resolving power of 10,000 combined with high photon flux "up to  $10^{12}$  photons per second" and variable polarization properties over a very wide energy range (200 - 3000 eV in the case of P04 at PETRA III). This allows both to address long standing discussions in photoionization physics such as the two-center interferences in  $N_2$  and  $O_2$  [1] with high precision over a broad energy range as well as to perform systematic low signal coincidence studies of e.g. the coherence properties of homonuclear diatomic molecules [2]. Results of exploratory first experiments performed

at BESSY (HZB, Berlin) and DORIS (DESY, Hamburg) on the valence photoionization of  $N_2$  and  $O_2$  will be presented and compared with theory [1, 3]. The results show that the oscillatory structure in the photoionization cross section of  $N_2$  and  $O_2$  regarded by Cohen and Fano as evidence for their model of coherent photoelectron emission from a two center system is in fact the appearance of a shape resonance. The real Cohen - Fano oscillations have a much larger wave length and are extended over a wide energy range.

### References

- [1] H. D. Cohen and U. Fano 1966 *Phys. Rev.* **150** 30.
- [2] B. Zimmermann *et al.* 2008 *Nature Phys.* **4** 649
- [3] D. Toffoli and P. Decleva 2006 *J. Phys. B* **39** 2681.

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