Applications of Synchrotron Radiation

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Synchrotron sources offer truly superior quality with respect to standard x-ray sources: very high brightness or brilliance, high flux, coherence, time structure, polarization. Their applications, therefore, open up a very extended array of experimental opportunities: the exploitation tends to be more a revolution than an evolutionary process.

We will briefly present examples in some of the most significant domains where this impact materialized in the past decades. We will begin with spectroscopic techniques, in particular the photoemission study of highly correlated systems including superconductors. We will then discuss the transition from standard spectroscopy to the combination of spectroscopy and microscopy known as "spectromicroscopy".

We will continue with the presentation of structural techniques, with specific emphasis on the biological applications. In particular, we will illustrate how synchrotrons are having a big impact on macromolecular crystallography.

The next topic will be radiology using coherent x-rays. We will see how the high lateral coherence of synchrotron sources makes now possible to perform radiology at the subcellular level and with high time resolution. The examples will span from the life sciences to technology, engineering and materials.

Finally, we will briefly illustrate how the above picture will be again revolutionized by the advent of free electron laser sources of x-rays with very short pulses and unprecedented spatial coherence and peak brightness. We will specifically discuss the possibility of structural techniques without crystals and its potential impact on membrane proteins.