Recent advances in Synchrotron UV Resonance Raman spectroscopy for exploring small and large molecules

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The advantages of UV Resonance Raman (UVRR) spectroscopy with respect to spontaneous Raman make UVRR technique a suitable method for exploring the structure of various molecular systems and materials [1]. The resonance enhancement not only leads to a significant increment of the detection limit, but also enables probing of specific parts of molecules trough an accurate tunability of the excitation wavelength. Moreover, Resonance Raman with excitation wavelength lower than 250 nm allows for a much better quality Raman spectrum to obtained due to the lack of fluorescence interference. This is particularly crucial for the case of samples dissolved in liquid solution where excitation in the visible or near-Infrared range does not yield Raman spectra with the same signal-to-noise ratio. The full exploitation of UVRR has so far been limited by the lack of tunable excitation sources of appropriate intensity that allow to finely approach the resonance conditions of specific targeted molecular groups. Additionally, the chance of extending the unique capabilities of UVRR to the UV domain (i.e. up to 8 eV) opens the possibility to cover the whole range of outer electronic excitations in matter. The synchrotron-UV Resonance Raman (SR-UVRR) instrument developed at BL10.2-IUVS beamline of the Elettra synchrotron radiation facility takes advantage from the wide and tunable emission in the UV range of the synchrotron source [2]. This offers the unique opportunity to finely tune the photon energy to exactly match the electronic absorption transitions of the sample, thus enhancing the Raman signal coming from a set of chromophoric segments in the molecules. SR-UVRR technique can be successfully exerted to characterize small and large molecular systems of interest in many scientific fields, including water and molecular liquids, polymers and gels, drug-carrier systems, biological molecules such as peptides, proteins and DNA, nanostructures and materials for cultural heritage. Selected case studies will be discussed in order to show the useful of SR-based UVRR method and the areas of interactions with other research interests, with particular attention to the study of biological macromolecules.

[1] Asher S.A., *UV Resonance Raman Spectroscopy for Analytical*, Physical, and Biophysical Chemistry. Part 1 Anal. Chem. (1993); 65(2), 59A-66°.
[2] B. Rossi, C. Bottari, S. Catalini, A. Gessini, F. D'Amico, C. Masciovecchio, *Synchrotron based UV Resonant Raman scattering for material science, Molecular and Laser Spectroscopy*, Volume 2 (eds V. P. Gupta, Y. Ozaki), Elsevier (2020), Chapter 13, pages 447-478.