FAR IR SPECTROSCOPY OF PRE-MAIN SEQUENCE STARS: The Lesson Learned from ISO and Perspectives

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We have recently analysed the ISO-LWS spectra (45-200 μm) of two classes of Pre-Main Sequence objects, the Herbig Ae/Be (HAEBE) and the FU Orionis stars. ISO-LWS has provided an unbiased view of the neighbourhood of the central object by sampling the physical scale ($\approx$ 80 arcsec) where the interaction with the closeby environment is taking place. The HAEBE sample, composed by 11 sources, shows relevant contributions from [OI] 63, 145 μm and [CII] 158 μm emission, mainly due to photodissociation excited by the star itself, given its early spectral type. In sources expected to have higher density circumstellar material, molecular emission is detected in form of CO and OH transitions. By comparing the molecular line cooling with model predictions, photodissociation, possibly in a clumpy medium, is suggested as the dominating excitation mechanism. Different results come from the far IR spectroscopic survey of 7 FU Ori objects. Again [OI] and [CII] lines are commonly observed in all spectra, but the observational novelty is the presence, in most of the sources, of the [NII] transition at 122 μm, which is not detected in other objects in a similar evolutionary phase. The interpretation of the observed spectra requires the presence of two components: well localised J-shocks, responsible for the [OI] emission, and an extended low density ionised medium produced by UV photons from the disc boundary layer, responsible for the [NII] and [CII] emission. A few molecular lines (from CO, OH, H_2O) associated with cold and dense peaks have intensities in good agreement with the proposed scenario. Other ionic lines at higher ionisation stages (*e.g.* [OIII]) are revealed in few HAEBE and FU Ori stars; while in the former case they are associated with the objects having spectral types earlier than B0, in the latter class they only trace the presence of nearby HII regions.

These far IR surveys have pointed out how remarkable aspects remain still unaddressed and have originated new questions which can be answered by using the capabilities offered by FIRST. In particular we will emphasize the importance of a better spatial resolution to study the internal structures of the detected PDR by tracing the transition zones $C^+/C^0/CO$, then clarifying whether or not clumpiness is an important ingredient. Moreover we discuss how to explain the lesser than expected [OI]63μm/[OI]145μm observed line ratios by studying whether this large scale behaviour stems from intrinsic properties of the emitting gas, or results from averaging different emission *vs* absorption components. Finally, ISO-LWS missed the fine structure transition of [NII] at 205μm instead observable with the instrumentation on board FIRST. We present diagnostic diagrams able to predict, by using the [NII] line pair, the electron density in the N^+ volume and the fractional ionisation in the environment around FU Ori objects, allowing to verify our hypothesis about the [NII] excitation mechanism.