Excitation and dynamics of the gas in planetary and proto-planetary nebulae: Optical, IR, and mm-wave data

V. Bujarrabal
Observatorio Astronómico Nacional, Apartado 1143, E-28800 Alcalá de Henares, Spain
bujarrabal@oan.es

Most of the material in planetary and proto planetary nebulae (PNe, PPNe) is been accelerated and excited by shock fronts, produced by the interaction between the slow but dense AGB wind and post-AGB ejections, diffuse but very fast and collimated. The molecular component, probed by mm and sub-mm wavelengths, is often very massive and represents the bulk of the nebular material. A good deal of this gas has been strongly accelerated by the shocks, although it has cooled down to very low temperatures, 10 – 30 K. (These structures are also observed by means of scattered light in the visible.) There is also a high-excitation component, with representative temperatures larger than 1000 K, observed by means of interaction between the slow but dense AGB wind and post-AGB ejections, diffuse but very fast and collimated. The molecular component, probed by mm and sub-mm wavelengths, is often very massive and represents the bulk of the nebular material. A good deal of this gas has been strongly accelerated by the shocks, although it has cooled down to very low temperatures, 10 – 30 K. (These structures are also observed by means of scattered light in the visible.) There is also a high-excitation component, with representative temperatures larger than 1000 K, observed by means of optical and NIR lines. Such a gas seems to correspond to clumps in the post-AGB jets excited by counter-shocks.

The description of the excitation state of the nebula needs information on the intermediate states, based on observations at intermediate frequencies. In particular, we have not identified the (forward) regions in which the dense gas is been accelerated, which is the main dynamical phenomenon in the shaping of PNe. ISO has observed fine-structure atomic lines, from gas at typically a few hundred K. However, a good spectral resolution, as that provided by HIFI/FIRST, is needed to conclude on the kinematics of this component. Such an information is also useful to discern between gas excited by stellar photons (PDRs) and shocked regions.