The Nucleus of our Galaxy

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The Galactic Centre (GC), in particular the interstellar material in the immediate vicinity of the central black hole (BH, the SgrA* radio source position) represents a unique environment for our understanding of the galactic nuclei and galaxy evolution. The nucleus of the Milky Way is a few hundred times closer than the nearest active galactic nuclei (AGN) thus allowing the highest possible spatial resolution studies of the material close to a supermassive BH. The nucleus of Milky Way is thus an incomparable laboratory to study a broad variety of GC phenomena, from black hole accretion and star formation in extreme physical conditions, to the impact of shocks, turbulence dissipation, magnetic fields and high-energy radiation in the interstellar medium. Despite its uniqueness and relevance in a broader extragalactic context, the central pc of the Milky Way is still poorly understood.

The distribution of gas and dust around Sgr A* consists of a central cavity of radius ~1 pc (~25'') containing warm dust and ionised gas heated and ionized by the central cluster of massive stars orbiting close to the BH (see Genzel et al. 2010 for a review). Some of the streamers of ionised gas (the "mini-spiral") bring material close to the very centre. The properties of the ionised gas and ionising sources can be readily inferred by studying its strong far-IR fine structure line emission ([Oiii]52,88, [Niii]57, [Nii]121,206μm, etc. in decreasing order of luminosity). The central cavity and the inner edges of the surrounding circum-nuclear disk (CND) also contain a substantial amount of hot neutral gas, detectable through very bright [Oi]63 and 145μm emission lines and also through a rich far-IR molecular line spectra dominated by high-J CO lines (up to J=30-29), water vapour and OH lines related with the presence of shocked gas (*e.g.,* Goicoechea et al. 2013). All these critical diagnostics cannot be observed with ALMA.

Owing to the much lower dust extinction effects compared to mid-IR observations and because of the strong emission from the interstellar component related to AGN and star formation activity, the relevance of far-IR spectroscopic studies to characterize nuclei has greatly increased thanks to *Herschel*'s observations of bright IR galaxies (*e.g.,* van der Werf et al. 2010; Sturm et al. 2011). Unfortunately, *Herschel* only reaches angular resolutions of 10''-30'' at far-IR wavelengths. At this resolution, extragalactic AGNs are unresolved and the emission from the central cavity in the inner parsec of our Galaxy can be barely separated from that of the surrounding CND. With an angular resolution of ~0.1'', a factor 100-300 better than that of *Herschel*, a far-IR sub-arcsecond observatory will peer into the GC and carry out spectroscopic-imaging of the above atomic and molecular diagnostics with unprecedented spatial resolution below ~1000 AU. This is roughly a factor ~3 better than the one achieved by the best VLBI sub-mas observations of Centaurus A, the closest AGN (Müller et al. 2011). Such a far-IR observatory will resolve the fundamental structures and sources in the GC at the required spatial scales (those of a clump of gas or of a protostellar envelope/disk/outflow). Essential questions related to the energy sources in the GC, the star formation in galactic nuclei and the mass accretion processes and feedback in the very centre of galaxies will be addressed.

Bibliography:

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