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GAS DYNAMICS IN THE GALACTIC CENTRE: CLUMP ACCRETION AND OUTFLOWS

J. Cuadra[1]

We present numerical models of the gas dynamics in the central parsec of the Galaxy, from its origin as stellar winds, until its capture by Sgr A*, the central massive black hole. We show that the gas forms a two-phase medium, with cold clumps embedded in a hot tenuous gas. We find the accretion rate to be variable, due to the effect of the stellar orbits and the stochastic accretion of clumps. We suggest that the recently discovered infalling cloud, G2, could be one of the predicted clumps. We also study the possibility of detecting the effect of a recent outflow from Sgr A*.

Our Galactic centre hosts the massive black hole Sgr A*, which is surrounded by young, massive stars. Some of these stars are in the Wolf-Rayet phase, and have mass-loss rates that could be as high as $10^{-4} M_{\odot}\,\mathrm{yr}^{-1}$. These stellar winds are the main source of material that Sgr A* currently accretes.

Thanks to infrared observations (e.g., Paumard et al. 2006; Martins et al. 2007), we know the orbital and stellar wind properties of this stellar population. We have developed numerical models of the gas dynamics of this region, using the stellar properties as input (Cuadra et al. 2005, 2006, 2008).

An interesting result from the numerical models is the formation of cold, dense clumps, likely due to thin shell instabilities in the shocks formed by the stellar winds (e.g., Vishniac 1994). Many clumps form, and a fraction of them are captured by the black hole, punctuating the accretion rate. One of these clumps could correspond to the G2 cloud, recently discovered on its way to be tidally sheared by Sgr A* (Gillessen et al. 2012, 2013).

We are currently extending the numerical models to include an outflow from Sgr A*, as recently revealed by X-ray observations (Wang et al. 2013). When outflows are present, the gas temperature and density profiles in the inner few arcseconds change dramatically, and the accretion rate is reduced. This effect lasts for a couple of centuries after the outflow is active, so we expect to constrain the strength of a possible outflow during that time-scale.

[1]Instituto de Astrofísica, Pontificia Universidad Católica de Chile, Santiago, Chile (jcuadra@astro.puc.cl).

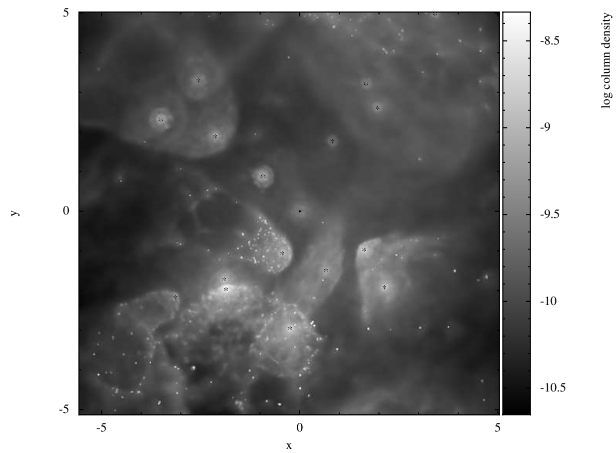

Fig. 1. Column density map from a simulation of the gas dynamics in the Galactic centre that includes stellar winds and an outflow from Sgr A*. The axis units are arcseconds. Notice the enhanced density at the centre and the presence of numerous small, dense clumps that formed where stellar winds shock.

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