The Galactic Center: Feeding and Feedback in a Normal Galactic Nucleus
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Young stellar objects close to Sgr A*

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Abstract. We aim at modeling small groups of young stars such as IRS 13N, 0.1 pc away from Sgr A*, which is suggested to contain a few embedded massive young stellar objects. We perform hydrodynamical simulations to follow the evolution of molecular clumps orbiting around a $4 \times 10^6 \mathrm{M}_\odot$ black hole, to constrain the formation and the physical conditions of such groups.

We find that the strong compression due to the black hole along the orbital radius vector of clumps evolving on highly eccentric orbits causes the clumps densities to increase to higher than the tidal density of Sgr A* and required for star formation. This suggests that the tidal compression from the black hole could support star formation.

Additionally, we speculate that the infrared excess source G2/DSO approaching Sgr A* on a highly eccentric orbit could be associated with a dust enshrouded star that may have been formed recently through the mechanism supported by our models.

Keywords. Galaxy: center — stars: formation — method: numerical

1. Modeling approach

We propose a possible scenario for stellar groups close to Sgr A*, such as IRS 13N (Eckart *et al.* 2004 and 2013; Muzic *et al.* 2008), by investigating star formation conditions on a clump scale within the circumnuclear disk (CND). To reach this goal, we study the contrasts between evolution of isolated and orbiting model clumps.

We use a smoothed particle hydrodynamics (SPH) method to simulate the evolution of clumps in the AMUSE framework (Portegies Zwart *et al.* 2013). The evolution of our model clump is followed using the *Fi* code (Pelupessy *et al.* 2004), integrated in AMUSE. The main physics in this study is the self-gravity of gas and the stellar interaction between newly formed stars.

Our model molecular clumps are isothermal and contain 100 $\mathrm{M}_\odot$ in < 0.2 pc radius, similar to clumps observed in the CND. We probe two different orbits (eccentricity=0.5 and 0.94) and test two temperatures (10 and 50 K).

2. Results

Figure 1 shows that the gas densities in the highly eccentric models reach the threshold densities (above the SMBH's tidal density) earlier than other models. Consequently, protostars (modeled using sinks) form when the threshold densities are reached. The

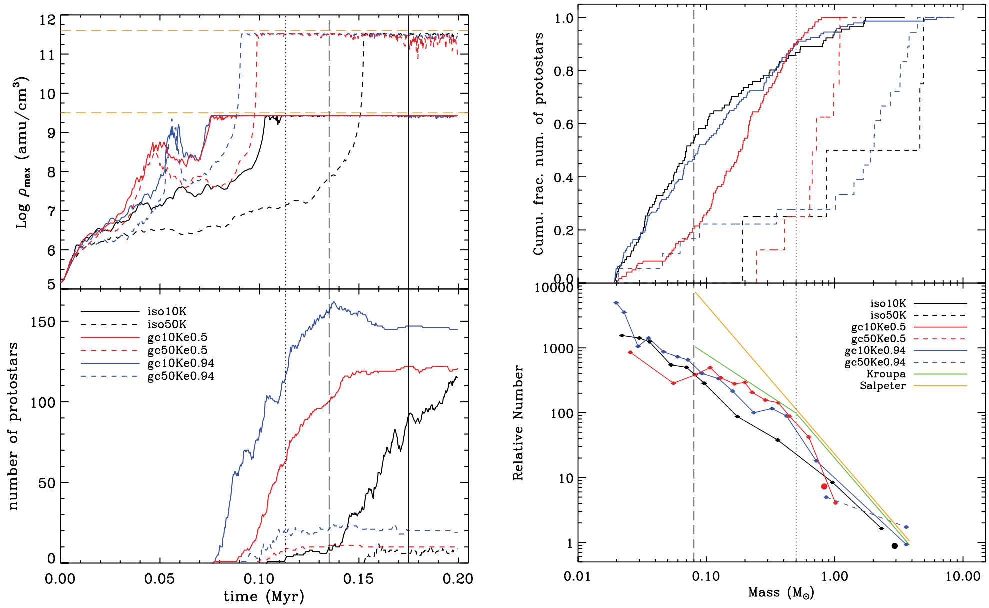

Figure 1. Left: The evolution of maximum gas densities and the number of protostars for each model. Symbols of all models are consistent in all panels. One orbital period is 0.113 Myr (vertical dotted line), one free fall time is 0.135 Myr (vertical dashed line) and the second pericenter passage is 0.175 Myr (vertical solid line). Orange horizontal lines are ρ_{thresh} values for 10 and 50 Kelvin models, respectively at about 2.69 $\times 10^9$ and 3.39 $\times 10^{11}$ $\frac{amu}{cm^3}$. **Right:** The cumulative number of protostars and the IMF of all models computed at 1.3 $\times$ t_{ff} ~0.175 Myr. In the lower panel, there is only one data point for the iso50K (larger black dot) and gc50Ke0.5 (larger red dot) models as there are only a few stars. The Kroupa and Salpeter slopes are overplotted with green and orange lines, respectively. [A COLOR VERSION IS AVAILABLE ONLINE.]

IMF of stars in all models are consistent with a Kroupa (2001) slope in the 0.1-0.5 M$_\odot$ range.

The gas column density of the highly eccentric 50 K model after 0.17 Myr is shown in Figure 2. The black circle marks a group of stars with properties similar to that of IRS 13N. Note that individual stars are indistinguishable in this image due to the large physical scale and projection effects.

3. Conclusions

Our results show that tidal compression from the black hole can support star formation in its vicinity. In the highly eccentric model clumps, a few groups of young stars with properties similar to IRS 13N are formed (Table 4 in Jalali *et al.* submitted). Our current models confirm the episodic star formation in the Galactic center region. The object G2/DSO (Gillessen *et al.* 2012, Eckart *et al.* 2013) could have originated from a young star that has formed in a clump similar to our highly eccentric model clumps close to the SMBH.

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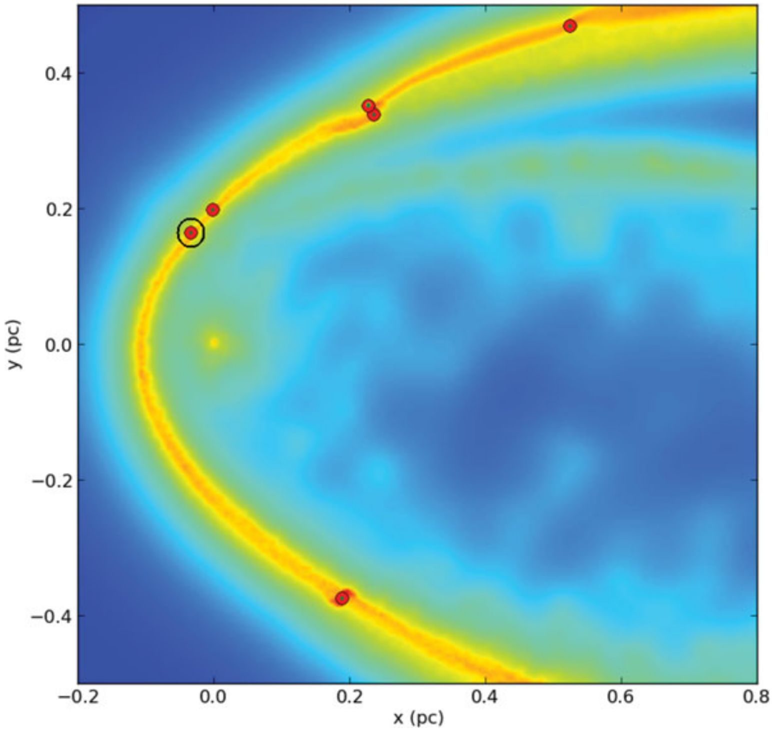

Figure 2. The column density of 50 K model with e∼0.95 at the pericenter passage. The gas density increases from blue to red on logarithmic scale. The black hole is situated at the origin (0,0). [A COLOR VERSION IS AVAILABLE ONLINE.]

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