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The Nuclear Star Cluster of the Milky Way

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Abstract. This contribution briefly summarizes the current state of our knowledge about the Milky Way's nuclear star cluster.

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1. The center of the Milky Way

The Galactic center (GC) is located at a mere 8 kpc from Earth, about a hundred times closer than the next comparable galaxy. It can thus provide us with unique data about the structure and evolution of a galactic stellar nucleus. Adaptive optics assisted observations with 8-10m-class telescopes in the near-infrared (NIR) allow us to resolve scales as small as 0.05", corresponding to about 8 mpc at the GC. On the downside, we must cope with the extreme interstellar extinction toward the GC that is caused by the line-of-sight through the Galactic Disk. At $A_V \approx 30$, observations in the visual regime are impossible. Fortunately, extinction decreases steeply throughout the NIR. With $A_K \approx 2.7$ toward the central parsec at $\lambda = 2.2\,\mu$m (Schödel *et al.*, 2010) we can study the distribution and kinematics of the stars in our Galaxy's nucleus.

Figure 1 presents an overview of the GC. The emission is dominated by stars in the the *nuclear bulge*, a disk-like region that stands out from the kpc-scale Galactic Bulge through intense far-infrared emission, ongoing star formation, a strong ionizing radiation field, large amounts of clumpy molecular gas, and an extremely high density of stars The nuclear bulge (sometimes also called *Nuclear Stellar Disk*) has a radius of ~230 pc, a scale height of ~45 pc and a total mass of $\sim 1.4 \times 10^9$ M$_\odot$ (Launhardt *et al.*, 2002).

2. Properties of the nuclear star cluster

The nuclear star cluster (NSC) is a compact entity at the center of the nuclear bulge. Its mass is estimated to be $3 \pm 1.5 \times 10^7$ M$_\odot$ and its half light radius to be ~3 pc (Launhardt *et al.*, 2002; Graham & Spitler, 2009). It must be stressed, however, that these values are highly uncertain because of the limitations of existing observations and the problem of differential extinction. We do not even know whether the NSC is spherical or not (its apparent elongation may in part be due to strong differential extinction, note the IR dark cloud south of the NSC in Fig. 1). The entire NSC rotates parallel to Galactic rotation (Trippe *et al.* 2008, Schödel *et al.* 2009).

The stellar density (e.g., Schödel *et al.* 2007) and velocity dispersion (e.g., Schödel *et al.* 2009) peak at the very center of the NSC, at the location of the 4×10^6 M$_\odot$ massive black hole Sagittarius A* (e.g., Gillessen *et al.*, 2009, Yelda *et al.* 2010). Hence, in the case of the Milky Way, there is no doubt that the NSC is truly central and that it co-exists with a massive black hole (MBH).

A question of special interest is the interaction between the stars and the MBH. Theoretical work predicts the formation of a *stellar cusp* within the sphere of influence of the MBH ($1 - 2$ pc) with a power-law number density of the form $\rho(r) \propto r^{-1.5 \ldots -1.75}$ if the system is older than a two-body relaxation time (e.g., Merritt 2006). The azimuthally

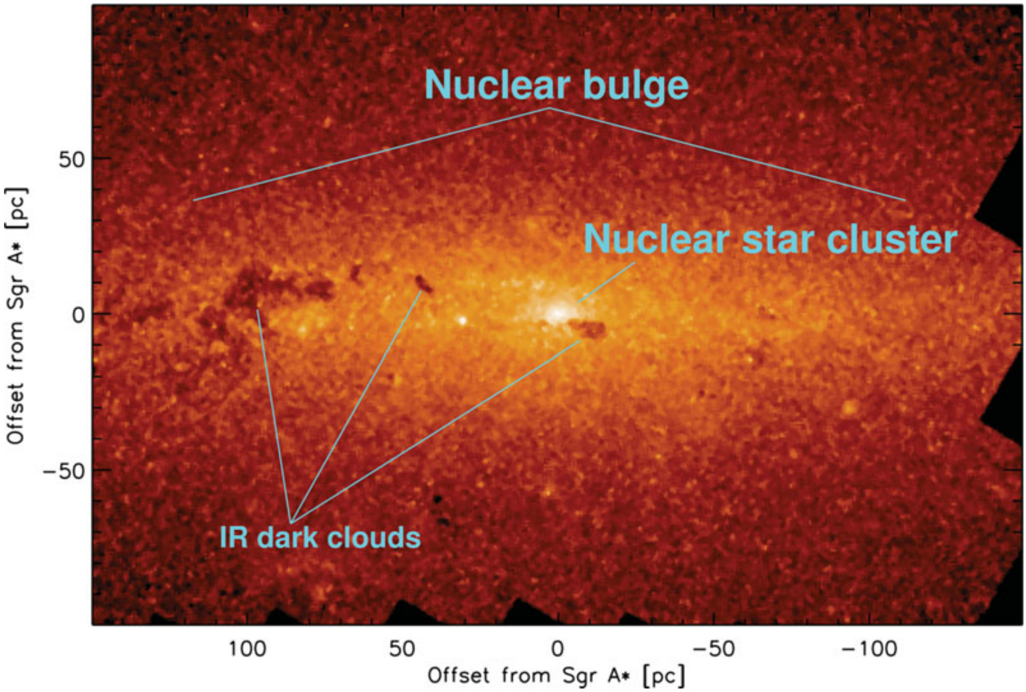

Figure 1. Extinction-corrected (using [3.6μm] − [4.5μm] colors) Spitzer/IRAC 4.5 μm image of the GC (see Stolovy *et al.*, 2006; re-binned to a 16" × 16" pixel size). Extinction reaches a minimum at this wavelength. The Galactic Plane runs horizontally across the middle of this image.

averaged number density of the NSC is $\rho(r) \propto r^{-1.75\pm0.1}$, i.e. close to the predicted value, but only at distances $r > 0.5$ pc from Sagittarius A* (Schödel *et al.* 2007). Further inside, the number density of the old – and therefore probably dynamically relaxed – stars is too flat to be consistent with the cusp scenario (Buchholz *et al.* 2009). This observation could be attributed to a number of reasons, like a very long relaxation time (Merritt 2010) or the effect of stellar collisions on giant stars (Dale *et al.* 2009). The presence (or not) of a stellar cusp at the GC must be considered ongoing research.

Similar to NSCs in other late-type galaxies, there are clear signs of recent star formation at the GC. Supergiants trace star formation about 100 Myr ago and young, massive stars within 0.5 pc of Sagittarius A* provide evidence of a star formation event a few Myr ago (Krabbe *et al.* 1995). There are indications that young, massive stars can be found throughout the entire NSC (Nishiyama & Schödel, 2012).

In summary, the Milky Way's NSC appears to be a close cousin to the NSCs found in other galaxies (Böker 2010).

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