The Galactic Center: Feeding and Feedback in a Normal Galactic Nucleus
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Structure of the nuclear stellar cluster of the Milky Way galaxy

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Abstract. Nuclear star clusters are unambiguously detected in about 50–70% of spiral and spheroidal galaxies. They have typical half-light radii of 2–5 pc, dynamical mass ranging from 10^6 – 10^7 $M_\odot$, are brighter than globular clusters, and obey similar scaling relations with host galaxies as supermassive black holes. The nuclear stellar cluster (NSC) which surrounds Sgr A*, the SMBH at the center of our galaxy, is the nearest nuclear cluster to us, and can be resolved to scales of milliparsecs. The strong and highly variable extinction towards the Galactic center makes it very hard to infer the intrinsic properties of the NSC (structure and size). We attempt a new way to infer its properties by using *Spitzer* MIR images in a wavelength range 3–8 μm where the extinction is at a minimum, and the NSC clearly stands out as a separate structure. We present results from our analysis, including extinction-corrected images and surface brightness profiles of the central few hundred parsecs of the Milky Way.

1. Introduction

The most comprehensive analysis of the morphology of the inner regions of the Milky Way galaxy published so far was by Launhardt *et al.* (2002), where they analyzed *IRAS* (2′ angular resolution) and *COBE* DIRBE (0.7° angular resolution) infrared images of the central 500 pc of the Galaxy, in particular the large-scale distribution of stars and gas in the nuclear bulge (NB), which is composed of the nuclear stellar disk (NSD) and the nuclear stellar cluster (NSC). They modeled the surface brightness profiles using empirical models and derived an outer radius of 230 pc, FWHM scale-height of 45 pc and a diameter-to-thickness ratio of 5:1 for the NSD, and an r^{-2} dependence in the NSC with a core radius of ∼0.22 pc, which dominates only the inner 20–30 pc region of the NB.

More recently, Schödel *et al.* (2011) obtained a half-light radius of ∼5 pc while Graham & Spitler (2009) obtained a half-light radius of 3.2 pc and a Sersic index of n=3 for the NSC. In the inner regions of the Galaxy, extinction caused by dust is a serious problem with visual extinction ranging from ∼30-50 (Rieke *et al.* 1985, Nishiyama *et al.* 2008, Gosling *et al.* 2009) and an extinction of A_k ∼3 even in the infrared bands (Schödel *et al.* 2010). Hence it is important to get an accurate measure of the extinction to study the intrinsic properties of the NSC.

2. Data and analysis

We used IRAC *Spitzer* images obtained by Stolovy *et al.* (2006) at wavelengths centered at 3.6, 4.5, 5.8 and 8.0 μm (channels 1 to 4, respectively). The observations cover the central 2×1.5 degrees of the Galaxy, which corresponds to ∼280×210 pc at a scale of 1″=0.039 pc, with a resolution of 1″ per pixel. Interstellar extinction is at a minimum at these wavelengths (see Fritz *et al.* 2011).

We used the images at 3.6 and 4.5 μm to create a color map (since stellar emission dominates at these wavelengths instead of hot dust and PAH emission, as is the case at 5.8 and 8.0 μm) by performing point-source photometry on the original maps using StarFinder (Diolaiti *et al.* 2000). Combining the stellar atmosphere models of Kurucz *et al.* (1993) with the corresponding IRAC filter transmission curves, we computed intrinsic [3.6–4.5] stellar colors. We used the extinction law $A_\lambda \propto \lambda^{-\alpha}$, where α=2.0±0.1. The value of α was determined by varying its value in steps and verifying the extinction correction by eye.

From the 8.0 μm image, which is dominated by PAH emission and emission from warm dust, it is possible to correct for the regions of excess emission due to warm dust seen in the extinction-corrected images, by subtracting the scaled extinction-corrected 8.0 μm image from the 4.5 μm image.

3. Structure of the nuclear stellar cluster

As a first order approach to determining the structure of the NSC, we created a one-dimensional azimuthally-averaged radial surface brightness profile from the extinction and dust-corrected image described in the previous section. We used MPFIT, an *IDL* routine for non-linear least squares curve fitting (Markwardt *et al.* 2009) of 1-d profiles to fit the radial profile using two components: a Sersic function describing the NSC and a constant contribution from the nuclear stellar disk and bulge. The best-fit model we obtained has a half-light radius of R_e=4.4±0.3 pc and Sersic index n=2.1±0.2.

To test the symmetry of the NSC, we also obtained flux-density profiles in conical sections of 45 degrees, perpendicular and parallel to the Galactic plane. The profiles indicate a flattening in the Galactic north-south direction, which agrees with rotation of the NSC parallel to the Galactic rotation (Trippe *et al.* 2008; Schödel *et al.* 2009) and is also suggested by simulations (Subr *et al.* 2004).

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