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An X-ray survey of the central molecular zone: variability of the Fe Kα emission line

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Abstract. The bulk of the Fe Kα emission detected in the central molecular zone (CMZ) is thought to be associated with reflection by the central molecular clouds of enhanced past emission from an external X-ray source, most likely Sgr A*. In order to follow the propagation of the reflected emission through the Galactic center (GC), we analyzed all *XMM-Newton* observations carried out from 2000 to 2012. Preliminary results indicate that while most of the regions that were bright at 6.4 keV in 2000–2001 have a significantly lower flux in 2012, a few other experienced a flux increase. We report for the first time a significant decrease of the Fe Kα emission in the Sgr C complex, supporting the reflection origin of the 6.4 keV emission detected in this region.

Keywords. ISM: reflection nebulae, Galaxy: center, X-rays: ISM, surveys, radiation mechanisms: nonthermal

1. The origin of the Fe Kα emission in the central molecular zone

The observations of Fe Kα line flux variability in different regions of the central molecular zone (CMZ; Muno *et al.* 2007, Inui *et al.* 2009, Terrier *et al.* 2010, Ponti *et al.* 2010, 2013, Clavel *et al.* 2013) suggest that in many places of the CMZ this emission and its associated continuum are most likely due to the illumination of the molecular matter by a bright and now extinct hard X-ray source, likely Sgr A*, rather than to irradiation by cosmic rays (Yusef-Zadeh *et al.* 2007, Dogiel *et al.* 2009, Tatischeff *et al.* 2012). In fact, a past flare of Sgr A* could have illuminated the CMZ clouds, which in turn produced delayed emission through Compton scattering and K-shell photo-ionization of iron (Sunyaev & Churazov 1998), leaving characteristic traces in the CMZ of a more active past of Sgr A*.

2. The *XMM-Newton* view of the Fe Kα variability

The analysis of more than 100 observations of the central degree area around Sgr A* performed with *XMM-Newton*, in particular during two full scans of the CMZ in 2000–2001 and in 2012 (Figure 1), allows us to follow the propagation of the reflected emission through the central 200 pc of our Galaxy. Large scale mosaic images of *XMM*/EPIC observations have been produced for different epochs in a narrow band centered at 6.4 keV.

Preliminary results indicate a significant decrease of the total 6.4 keV emission in

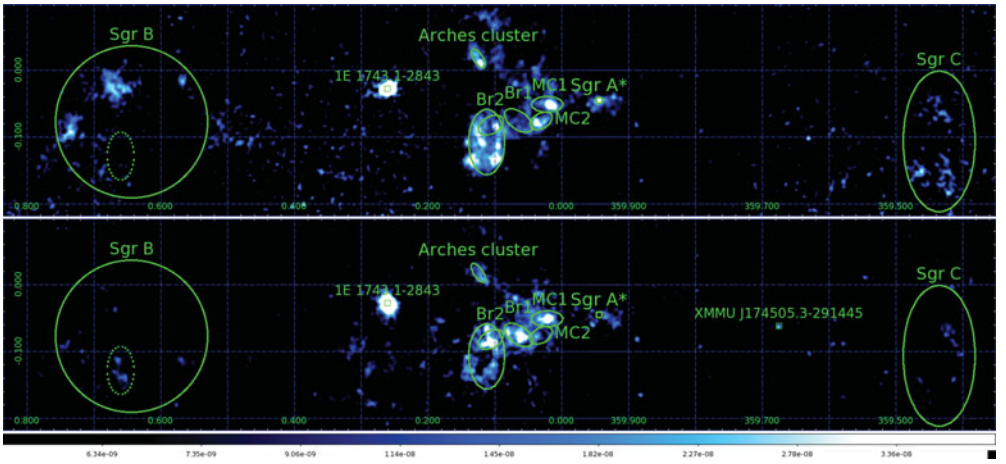

Figure 1. Background- and continuum-subtracted intensity maps of the inner GC region measured by *XMM-Newton* at 6.4 keV in 2000–2001 (**top**) and 2012 (**bottom**; maps in units of ph cm^{-2} s^{-1} pixel^{-1}, with 2.5″ pixel size and to which a Gaussian smoothing with a kernel radius of 7 pixels has been applied). Some of the Fe Kα bright molecular complexes are indicated with ellipses, while some point sources are marked with squares (see Soldi *et al.* 2013 in these proceedings for the new X-ray transient XMMU J174505.3−291445). [A color version is available online.]

the CMZ. This can be clearly observed on a large global scale in the Sgr B molecular complex (Figure 1), even though some specific sub-regions appear to have brightened, as for example the region in the dashed ellipse of Figure 1. We report here for the first time a significant (by a factor of 2 within 11 years) variation of the Fe Kα emission in the Sgr C complex. Figure 1 shows that such variations are present on scales from 10′ down to one arcmin. Previously, only a low-significance 8% variation in just one region of the complex had been reported (Ryu *et al.* 2013). The observed fast variability favors the reflection scenario over a cosmic ray origin for the Sgr C sub-regions where such variations are observed. In the Sgr A complex, the propagation of the emission away from Sgr A* (within the regions labeled 'MC' and 'Br' in Figure 1) is continuing, consistently with the previously reported echo moving through the GC (Ponti *et al.* 2010, Clavel *et al.* 2013).

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