

Unbiased line surveys of molecular clouds in the Galactic center region

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Abstract. Using the IRAM 30 m telescope, we perform a molecular line survey of the 3 and 2 mm wavelength ranges towards 5 selected positions in the Galactic center region, sampling shocked regions, ultraviolet (UV) and X-ray pervaded regions, and positions with rich organic chemistry. These surveys have the potential to be used as chemical templates for different types of activity, such as photodissociated regions (PDRs), shocks and X-ray dominated regions (XDRs). Complementary, molecular surveys done towards extragalactic nuclei, that are also dominated by these physical activities, were carried by our group.

1. Introduction

The molecular clouds in the Galactic center (GC) are influenced by large gravitational potential gradients and exposed to very energetic activities -unique in the Galaxy- that influence their physical conditions and their chemistry. The study of the GC offers us an excellent opportunity to explore in detail the chemical and physical processes present in the center of the galaxies. To construct a comprehensive and complete chemical classification of galactic nuclei, we need unbiased spectral surveys at the high spatial and spectral resolution that are attainable in our GC. In this contribution we present a spectral survey towards five positions in the GC that are representatives for different kinds of environments and activities in galaxies. This survey has the potential to give clues to the underlying physical conditions in different kinds of nuclei.

2. Line survey

We selected five positions from Martín *et al.* (2008), including shocked regions, UV and X-ray pervaded regions, and positions with rich organic chemistry (Requena-Torres *et al.* 2006). Three positions are located in the Sgr A molecular cloud. One of them is located in the circumnuclear disk (CND, Sgr A* ($-30''$, $-30''$)). One position is located in Sgr B2 and one in the dust ridge. We covered a frequency range from 79.6 to 115.9 GHz in the 3 mm band (see Figure 1), and from 128.5 GHz to 175.5 GHz in the 2 mm band.

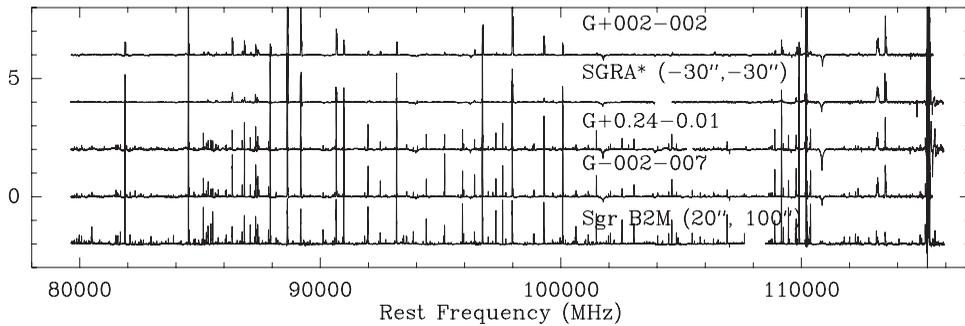


Figure 1. Molecular line survey in the 3 mm wavelengths for all the observed positions. Temperature are in T_A^* . We follow the notation of Martín *et al.* (2008).

We have recently extended the survey to the submm regime using the FLASH receiver on the APEX telescope (Hochgürtel 2013, doctoral dissertation). With this comprehensive frequency coverage, we can estimate accurate column densities of different molecular species that will represent a rich data set that serves as the basis for chemical modeling carried out by our group (see contribution by Harada *et al.*).

3. External galaxies and implications

We have carried out a 3 mm line survey using the 30-m telescope in a set of bright extragalactic sources that will serve as prototypes for the different activity types: NGC 253 and M83 are early stage starburst; M82 and M51 are later in their evolution; NGC 1068 is the prototypical AGN, and Arp 220 the archetypal ultraluminous infrared galaxy (ULIRG) with an enormous concentration of molecular gas in its central region. A comparison of the abundances of different molecular species in the nuclear regions of NGC 1068, M 82, and NGC 253 allowed us to establish chemical differentiation between starburst galaxies and AGN (see Aladro *et al.* 2013 for details). One abundant species in starburst galaxies, CH_3CCH , is not detected in NGC 1068, probably because it is destroyed by UV fields or shocks. On the other hand, species such as CN, SiO, HCO^+ , and HCN, are enhanced by enhanced cosmic rays fluxes. These surveys, in combination with former work carried out by our group (2 mm line survey of NGC 253 by Martín *et al.* 2006; 2 mm and 1.3 mm line survey M82 by Aladro *et al.* 2011; the new APEX spectral surveys in external galaxies (NGC 253, NGC 4945, Arp 220, Villicana *et al.* in prep); the recently published 3 mm survey of Sgr B2 by Belloche *et al.* 2013; and our 3mm line survey of the GC sources) will be used as the chemical templates of different types of activity (PDRs, shocks, XDRs). We have shown that the spectral scans provide unique information on the type of activity and evolutionary state of the nuclear regions of galaxies.

References

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