Molecular Fireworks: The high angular resolution 2-3 mm molecular line survey covering the central arc minute of the Fireworks Galaxy NGC 6946

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Molecules allow us to probe the physical properties of the interstellar medium, such as its temperature, density, and kinematics. They have been useful in, for example, understanding the conditions within local star forming regions. However, more extreme environments exist within the universe. One of these are the centres of galaxies where cosmic ionization rates, dust, and gas temperatures are several orders of magnitude higher, which can affect the chemistry and excitation of the lines. It is therefore critical to constrain the emission of molecular lines within galaxy centres to gain a more complete understanding of these important astronomical tools.

In this poster-talk I will present high resolution (2−4″;~100pc) and high-sensitivity IRAM Plateau de Bure Interferometer observations of many molecular lines within the 2 and 3 mm windows towards the central ~2kpc of the nearby, gas-rich, very actively star-forming double-barred spiral galaxy NGC 6946 [1]. In total, we detected fourteen molecular emission lines, which are tracing various physical states of the interstellar medium such as dense gas (e.g. HNC), shocks (e.g. CH3OH), and complex chemistry (e.g. C2H). We identify the inner small scale bar within the centre of NGC6946 (based on the work of [2]) where we see prominent molecular line emission in three distinct regions: the nuclear region and the northern/southern inner bar ends. Our analysis suggests that the presence of this inner bar has a strong effect on the observed line emission. For example, we find higher molecular mean density and higher star formation rates correlate with the shock tracers towards the southern inner bar end.

We investigate the centre of NGC6946 in terms of (i) how the molecular lines relate to NGC6946's star formation rate (SFR), (ii) how the density tracers correlate with SFR (iii) what the empirical line ratios diagnostics indicate. For the latter, we are using ancillary data (EMPIRE dense gas observations [3], high resolution observations of M51 [4] and NGC3627 [5]) and investigate whether the ratio of HCN/HNC is kinetic temperature sensitive and and if the HCN/HCO+ ratio can reflect AGN activity.

This first survey paper highlights the diagnostic potential of covering the full 2 and 3 mm bands while pushing to molecular cloud scales in extragalactic environments.

References

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