

# Cosmic-ray ionisation of molecular gas

## HCO<sup>+</sup> mapping with ATCA

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# Cosmic-ray ionisation of molecular gas

Molecular gas is generally neutral; but there is some ionisation.

- 1 ionisation allows magnetic regulation of cloud dynamics eg star formation
- 2 molecular ions drive chemistry through ion-molecule reactions

Photoionisation happens through UV flux at cloud ‘surfaces’

Cosmic rays ionise material deep inside the cloud

We generally use  $\zeta$  – the rate of cosmic-ray ionisation in  $\text{s}^{-1}$

# Cosmic-ray ionisation and CTA

We know that it's more complex than  $\zeta$

CTA is a machine to image the interaction of cosmic rays with molecular gas

We want to compare maps of molecular gas, molecular ions, and cosmic-ray interaction

## HCO<sup>+</sup> as a tracer

HCO<sup>+</sup> is the molecular-ion equivalent to CO; fairly abundant, easy to detect

HCO<sup>+</sup>/CO can be used to estimate the ionisation rate  $\zeta$  (Caselli et al 1998)

DCO<sup>+</sup>/HCO<sup>+</sup> can be used to estimate the electron density  $n_e$ ;

but DCO<sup>+</sup> is difficult to observe

DCO<sup>+</sup> is observable from OSO, IRAM, ALMA(!)

An HCO<sup>+</sup> survey

- allows us to target DCO<sup>+</sup>
- could be used to motivate stronger DCO<sup>+</sup> infrastructure in the southern hemisphere

# Mapping with ATCA

HCO<sup>+</sup> 1–0 is at 89.2 GHz, well within the capability of ATCA 3mm band (<~ 110 GHz)

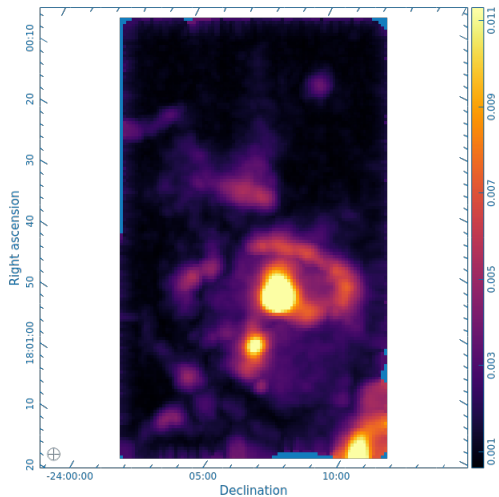
ATCA has a demonstrated capability to use 5 antennae as single-dish telescopes simultaneously

(originated by Chris Jordan for MALT45, StarFISH...)

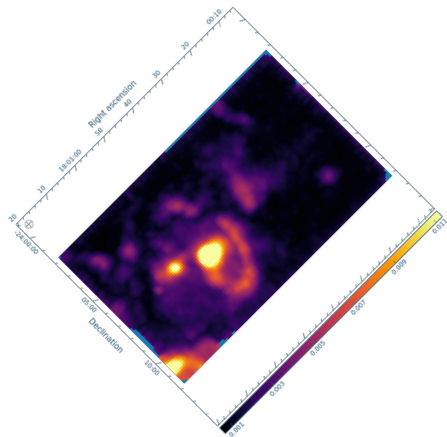
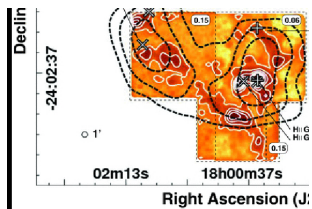
So we should be able to use the same technique for 3mm



# Southern source



# 2021 results





# Moving on

Mapping works!

We have maps of other parts of W28 as well, but there are some processing issues to be sorted out.

Priorities:

- Science!
- Can we go faster? (probably, yes...)
- Do we need to basket-weave?
- Calibration

Dec 15 ATCA deadline.

Coming up... BIGCAT!

Also... Parkes?