Spectral line science with ATCA

Max Voronkov | ATCA Science day – 08 April 2025

Lots of spectral lines beyond HI

(Quasi)thermal

Harder with ATCA used as
an interferometer

Masers

qualitative

Estimate of physical parameters (e.g. T, density), abundance

Astro-chemistry and tracers of shocked gas and interactions

Kinematics (including kinematic distance), morphology

Magnetic fields & Zeeman splitting (OH in particular)

Recombination lines

Ionisation, electron temperature and density, metalicity
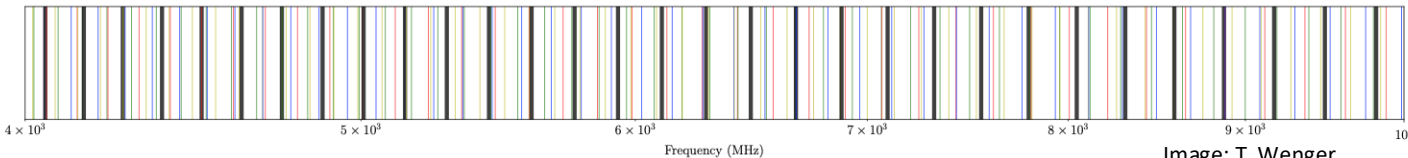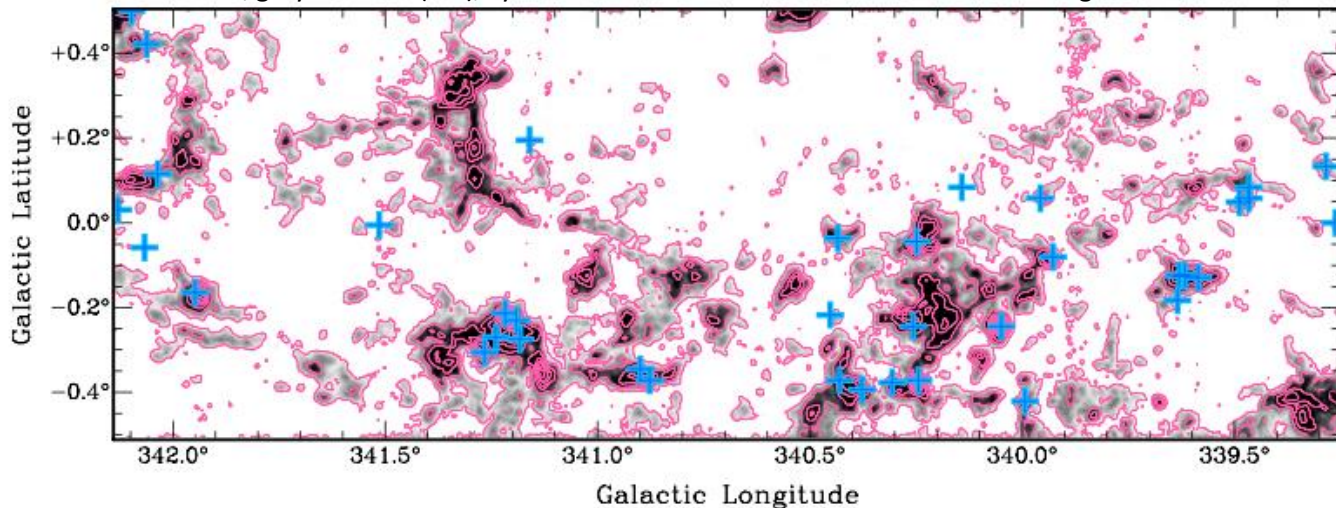
Kinematics of HII regions and their interaction

Frequency (MHz)

Image: T. Wenger

StarFISH: ATCA as Mopra++

Star **F**ormation **I**n the **S**outhern **H**emisphere (PI: S.Breen)

Contours/greyscale: CS (1-0), symbols – class I methanol masers at 44 GHz. Image credit: S.Breen

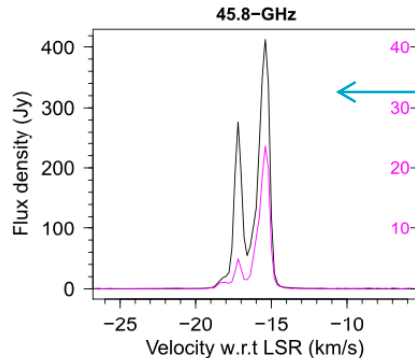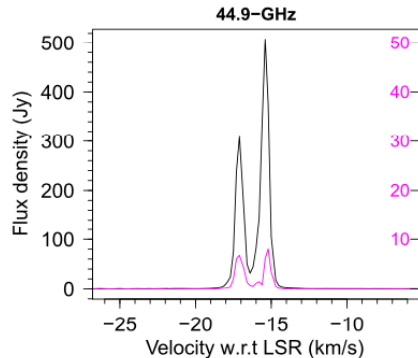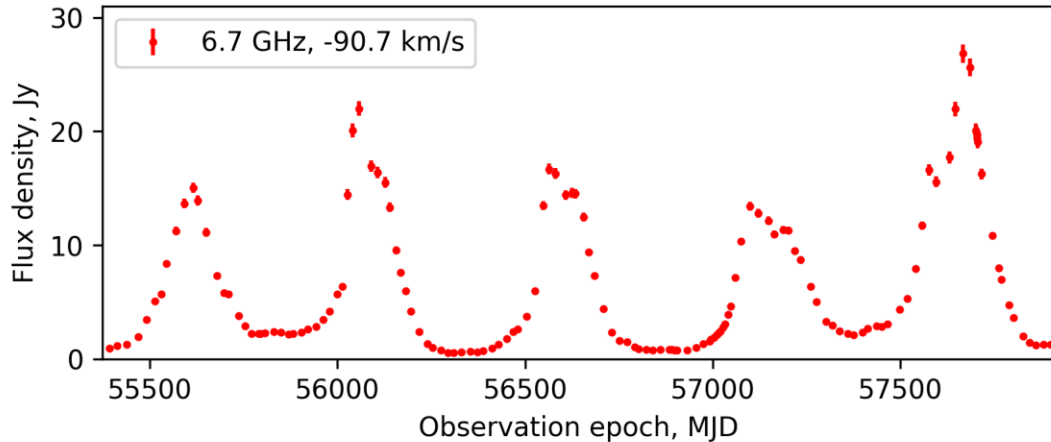| Transition	Frequency, GHz	Transition	Frequency, GHz
SiO (1-0) v=3	**42.51934**	H51α (RRL)	48.15360
SiO (1-0) v=2	**42.82048**	C^{34}S (1-0)	48.20694
H53α (RRL)	42.95197	CH$_3$OH 1_0-0_0 A$^+$	48.37246
SiO (1-0) v=1	**43.12203**	CH$_3$OH 1_0-0_0 E	48.37689
SiO (1-0) v=0	43.42376	OCS (4-3)	48.65160
CH$_3$OH 7_0-6_1A$^+$	**44.06941**	CS (1-0)	48.99095

ATCA is used as
6 single dishes

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Periodic variability and bursts in masers

About 30 (quasi)periodic masers known (largely class II methanol)

Example from my own monitoring work → with ATCA

G331.13-0.24

6.7 GHz, -90.7 km/s

Flux density, Jy

Observation epoch, MJD

44.9-GHz

45.8-GHz

Flux density (Jy)

Velocity w.r.t LSR (km/s)

Flare in G358.931-0.030 (Breen et al., 2019, ApJ, 876, 25)

Lots of unusual transitions!

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Benefits of the new system

- More user-friendly / (hopefully) less bugs
- Better spectral resolution options, especially for 12mm
- Potentially different spectral resolution for masers and thermal lines and RRLs
- More flexible positioning of zooms, better default resolution (i.e. no zooms needed for high frequency)
- Main benefits are with the RF upgrade and 8 GHz
    - More stuff observable simultaneously
    - Can finally get 12.2 GHz methanol line (surveys, VLBI?, monitoring together with 6.7 GHz)

Wishlist

- Simultaneous observations at 36 and 44 GHz
- Mopra 3mm receivers at ATCA antennas

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Thank you

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