LWS Spectral Survey of Sagittarius B2

Edward Polehampton

Rutherford Appleton Laboratory / Oxford University, UK

Overview

- Observations made
- Improvements due to non-prime Fabry-perot data
- Results
  - Atomic lines
  - Deuterium
  - OH
- Implications for other datasets

Sagittarius B2

- A giant molecular cloud complex located ~100 pc from the Galactic Centre
- Many LWS observations made of this source:

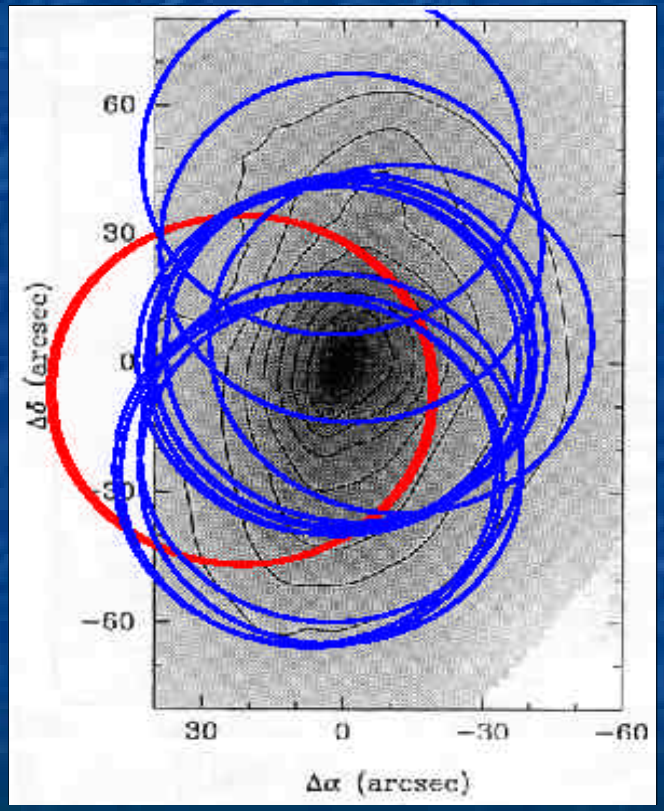
Mode	*Obs.*	*Time*	*sampling*
FP wide scan (L03)	36	53.6 hours	3-6
FP line scan (L04)	23	17.5 hours	>10
Grating wide scan (L01)	18	8.75 hours	

Fabry-Perot resolution " 30 – 40 km s^{-1}

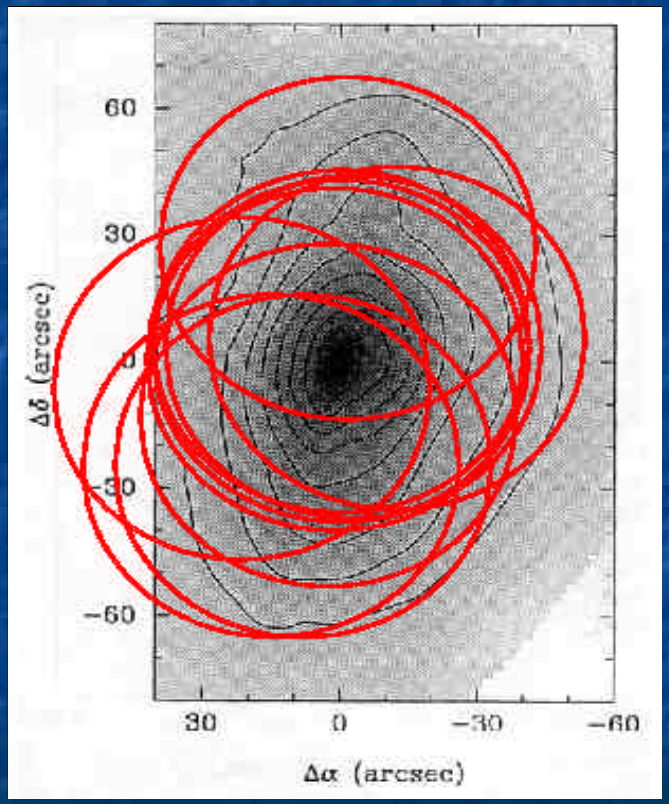
Grating resolution " 1000 – 1500 km s^{-1}

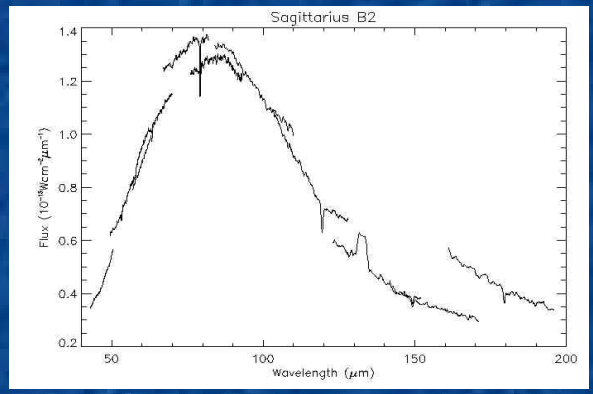
LWS pointings towards Sgr B2

Fabry-Perot



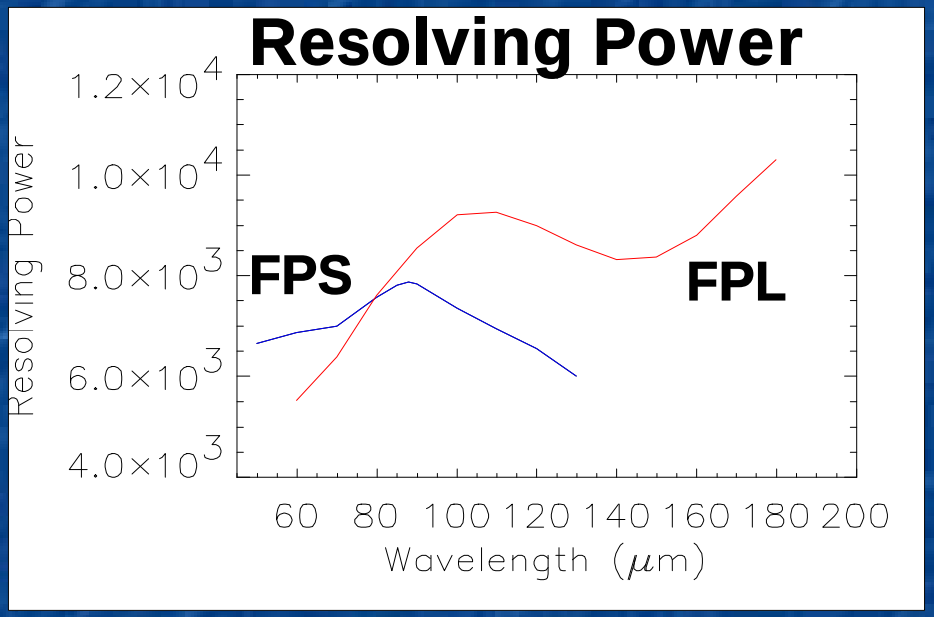
Grating

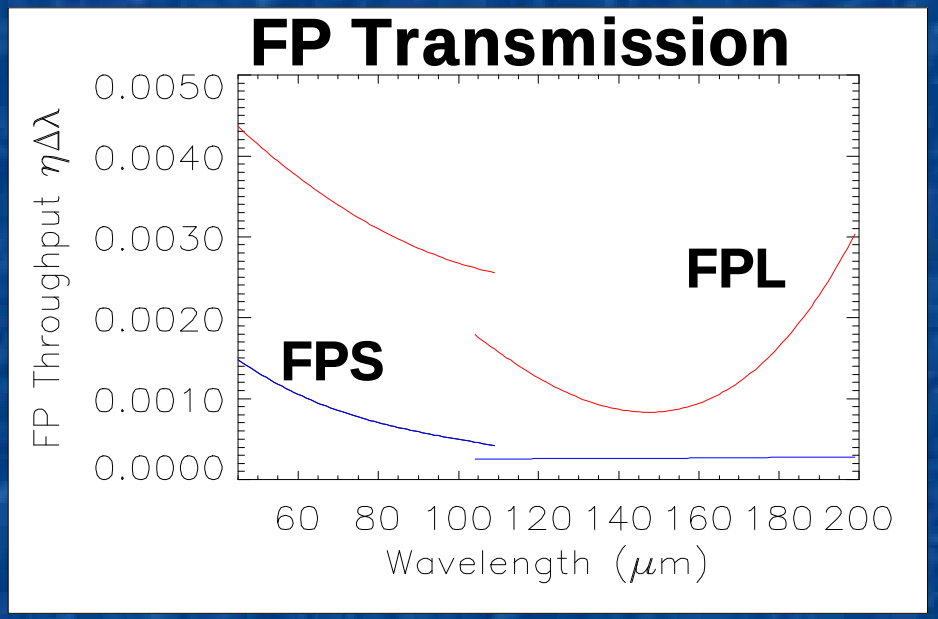




(100 μm KAO map from Goldsmith et al. 1992)

- Two Fabry-Perots cover the wavelength range 47 – 198 μm.
- Data were recorded by 10 detectors simultaneously.
- In each observation the instrument settings were optimised for one detector only g the 'PRIME' detector.

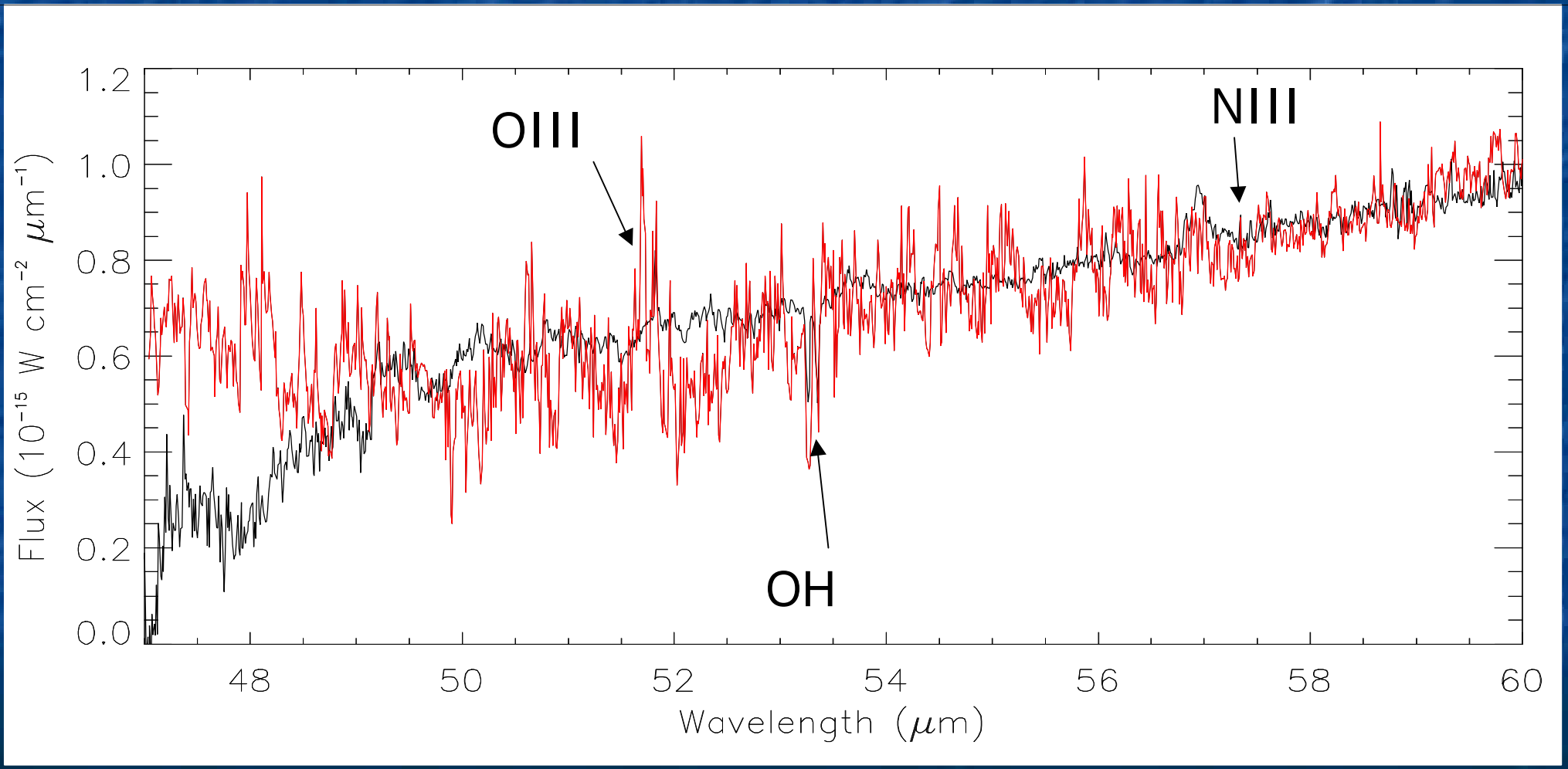




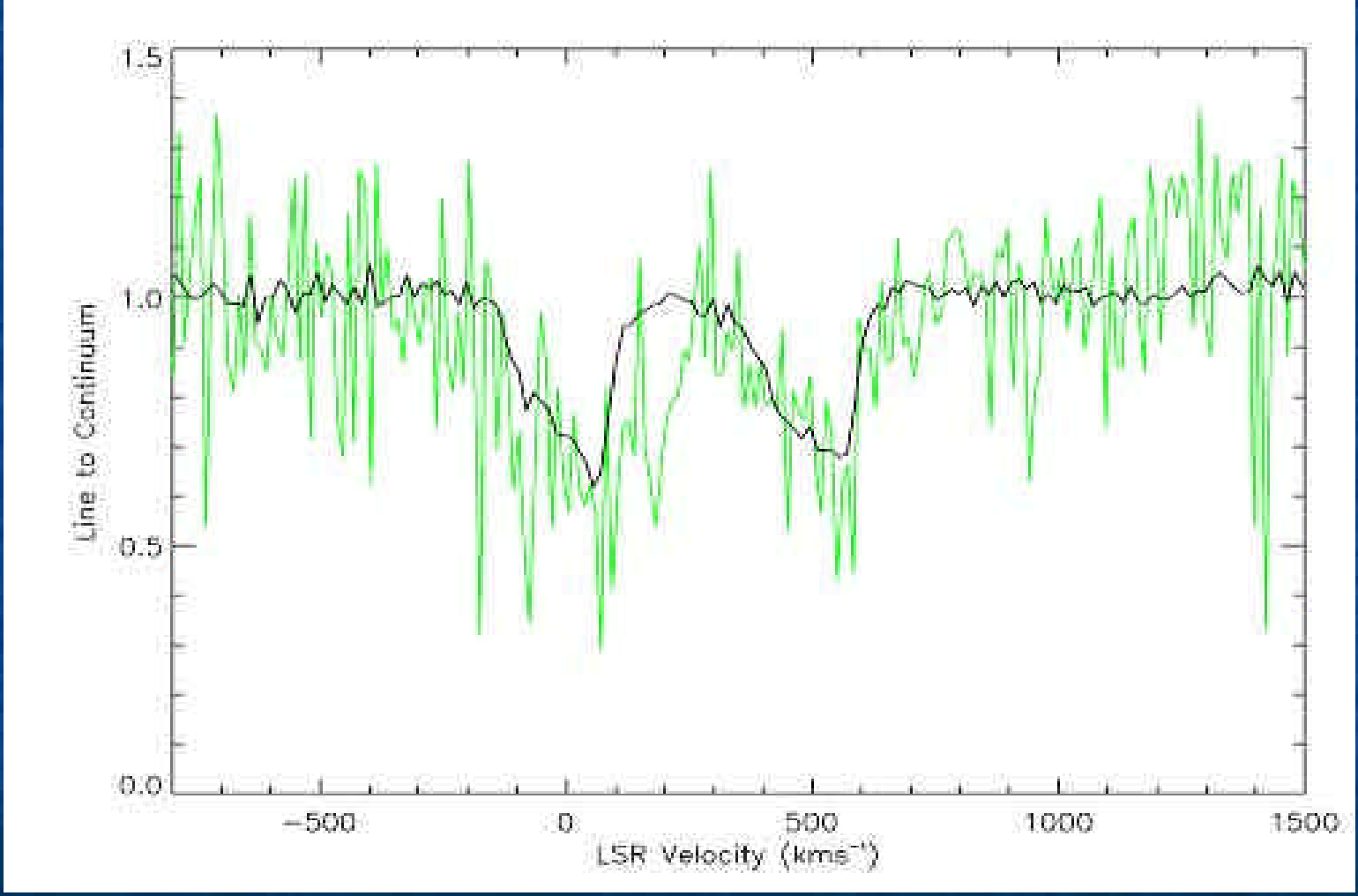
The short wavelength FP ('FPS') provides higher spectral resolution below 70 μm

BUT has lower S/N than the long wavelength FP ('FPL').

FPL data below 70 μm can be recovered from the ‘non-prime’ detectors...



53μm OH line


1.5
1.0
0.5
0.0
Line to Continuum
−500
0
500
1000
1500
LSR Velocity (kms⁻¹)

Results

- Approximately 80 identified lines.
- Many weaker lines have not been identified yet.

NH_3 - 21 absorption lines *(Ceccarelli et al. 2002)*

HD in emission *(Polehampton et al. 2002)*

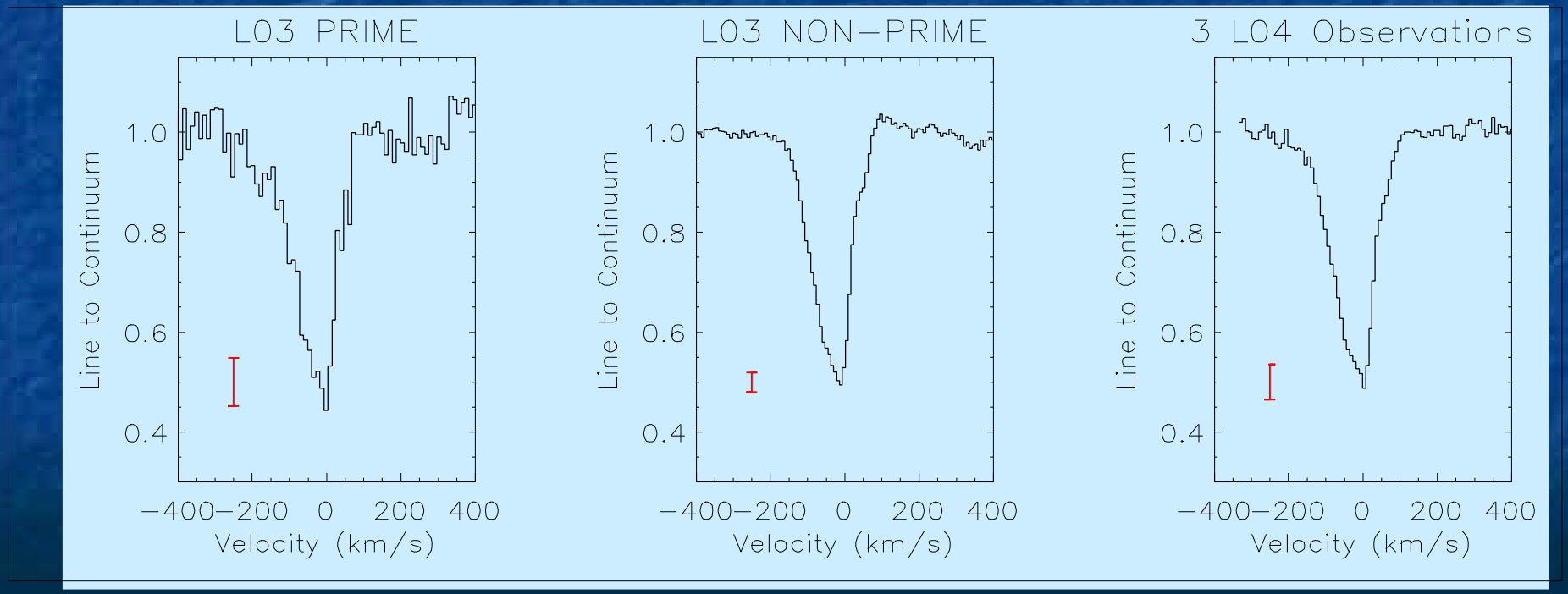
OI, **CII** in absorption/emission *(Vastel et al. submitted)*

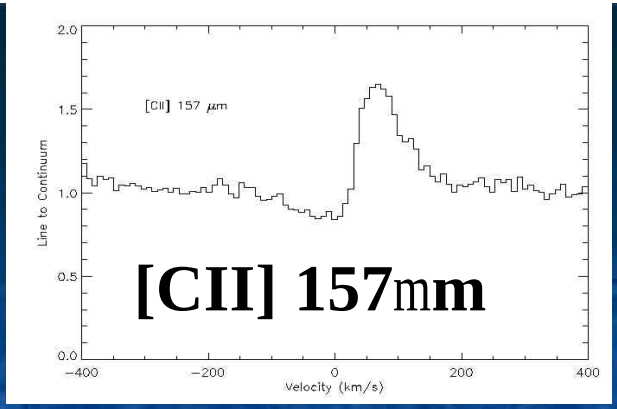
Also : **H_2O**, **OH**, **H_3O^+**, **CH**, **CH_2**, **NH_2**, **NH**.....
OIII, **NII**, **NIII**....

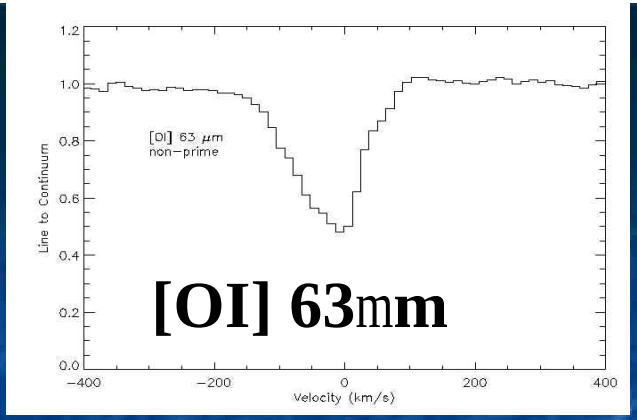
see poster by Goicoechea et al.

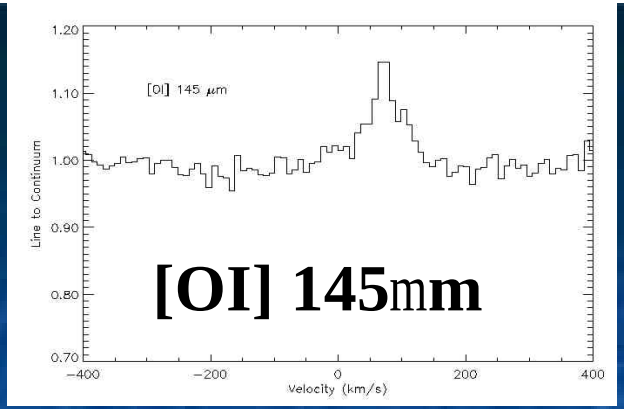
Atomic cooling lines

- The OI 63 μm line is seen in absorption throughout the line of sight.
- This line was observed in L03 and L04 modes.

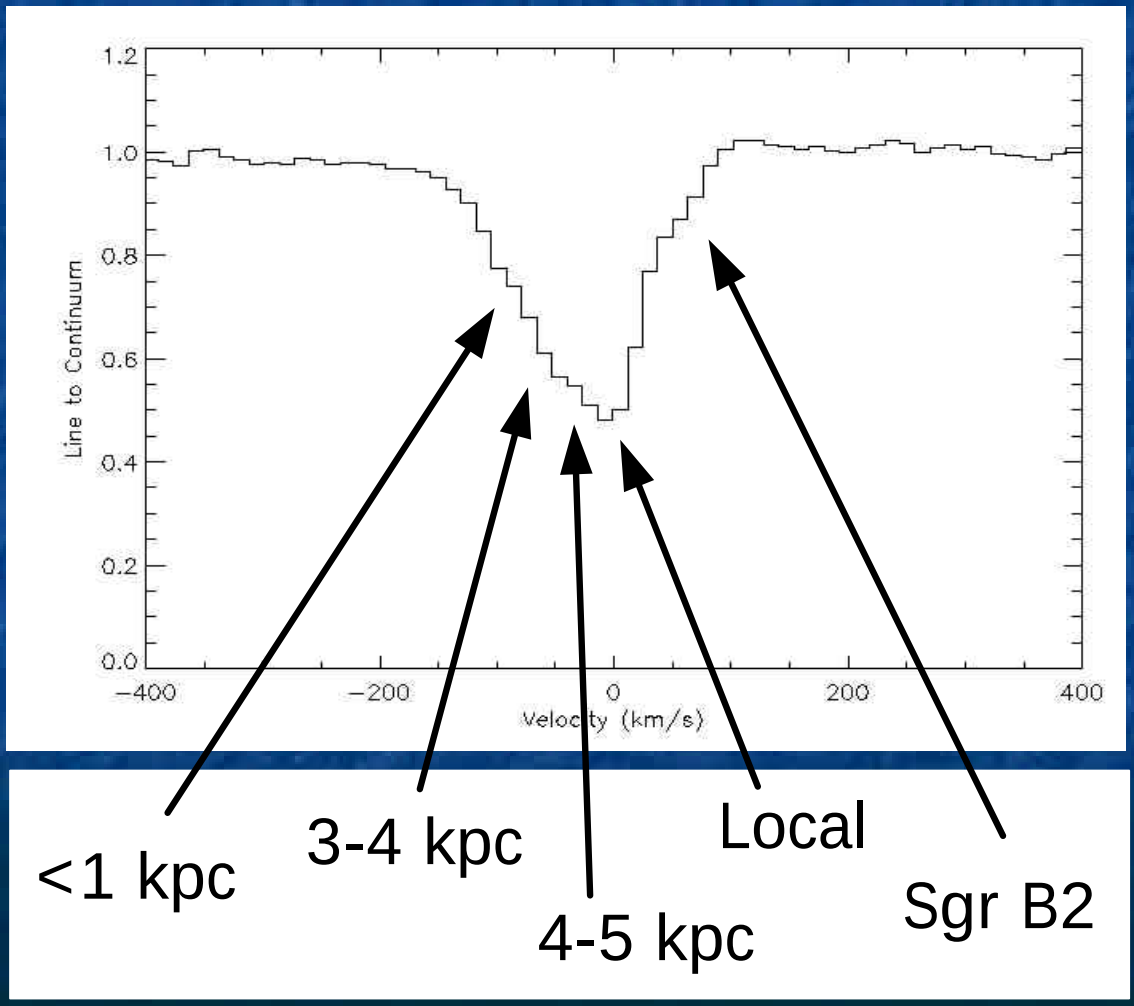






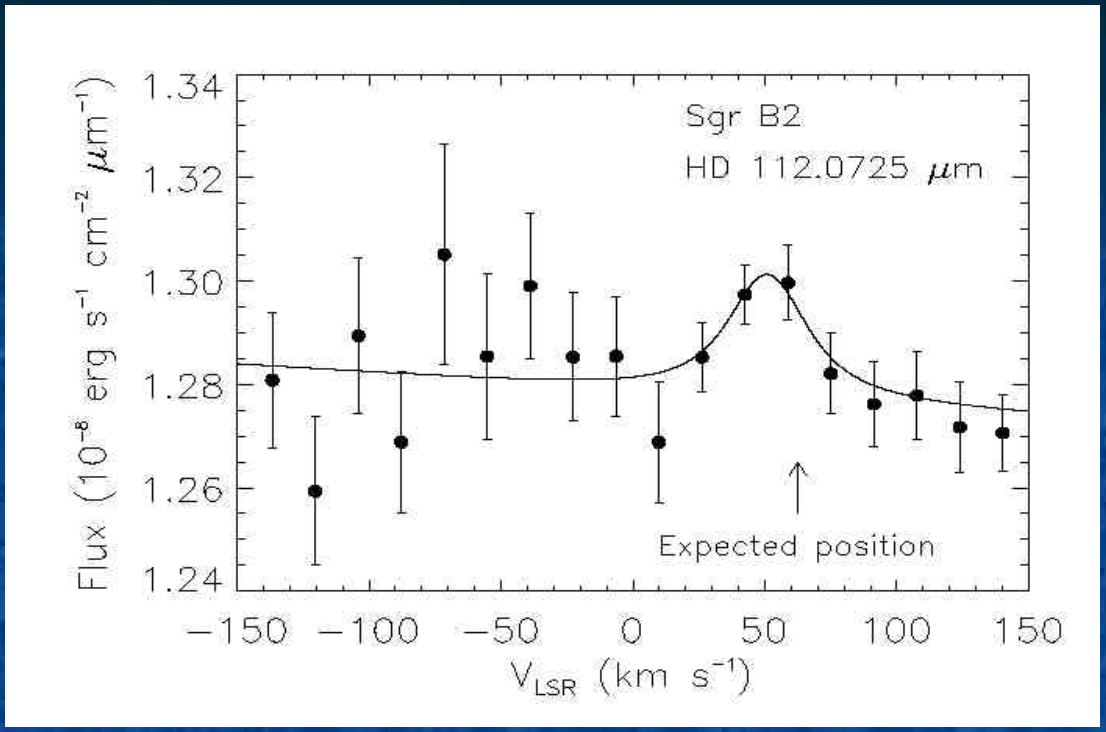


- The absorption is due to clouds in the Galactic Spiral Arms along the line of sight.
- See the poster by C. Vastel et al. for details.



Deuterium in Sgr B2

- D/H is expected to be lower in the Galactic Centre.
- The HD molecule provides a good way to measure deuterium in dense molecular clouds.
- 2 HD rotational lines occur within LWS range.



$J = 1 \gamma 0$

112 μm

$J = 2 \gamma 1$

56 μm

- $N(HD) = (0.7 - 11) \times 10^{18}$ cm^{-2}

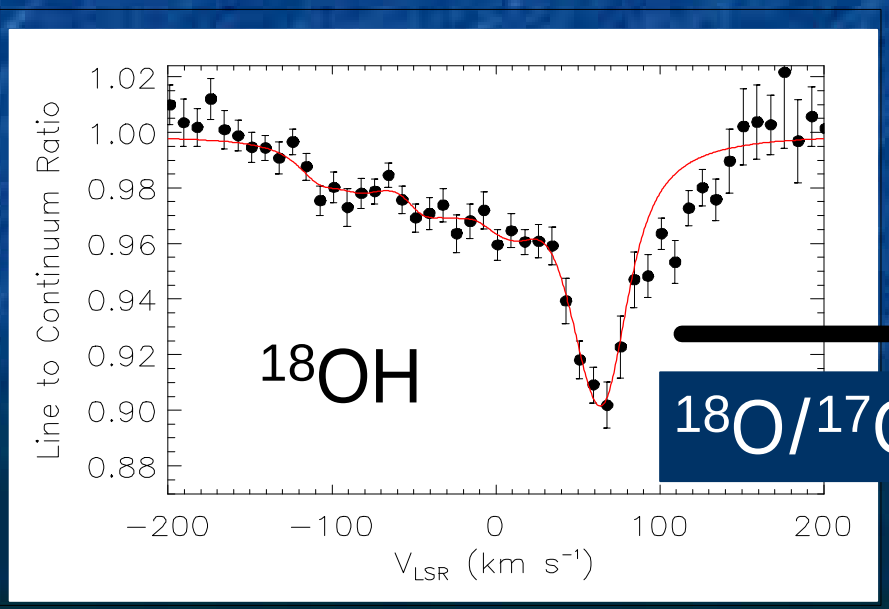
  (depending on temperature in emitting region)

- Taking $N(H_2)$ from dust observations gives,

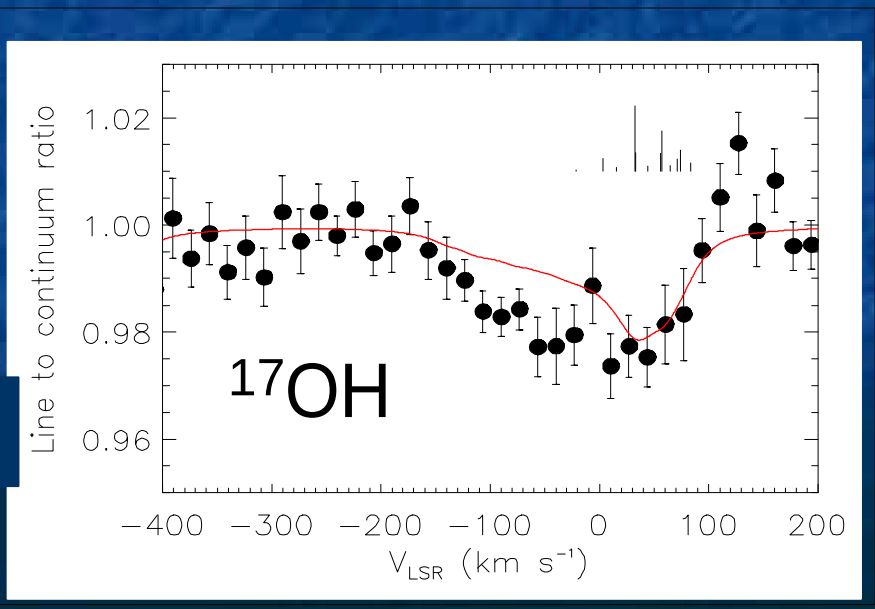
  $D/H = (0.2 - 11) \times 10^{-6}$

^{16}OH ^{17}OH ^{18}OH

- Ground state rotational transitions are observed from ^{16}OH, ^{17}OH and ^{18}OH.
- Higher rotational levels are observed from ^{16}OH in Sgr B2 itself.
- These lines can be modelled to determine the oxygen isotopic gradient through the galaxy.



$^{18}O/^{17}O=3.5$



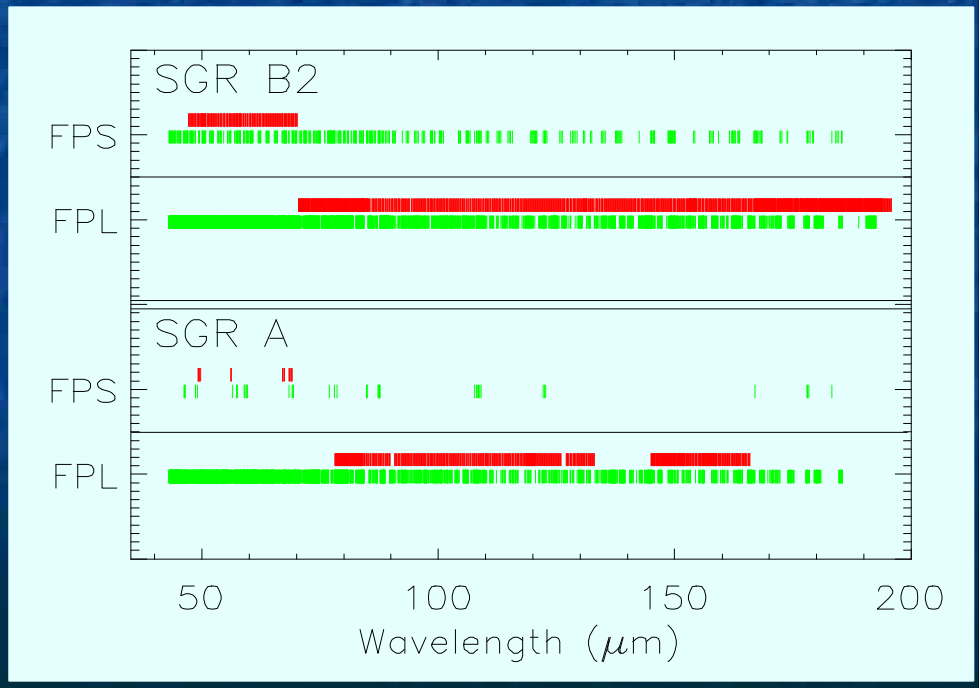
Application to other observations

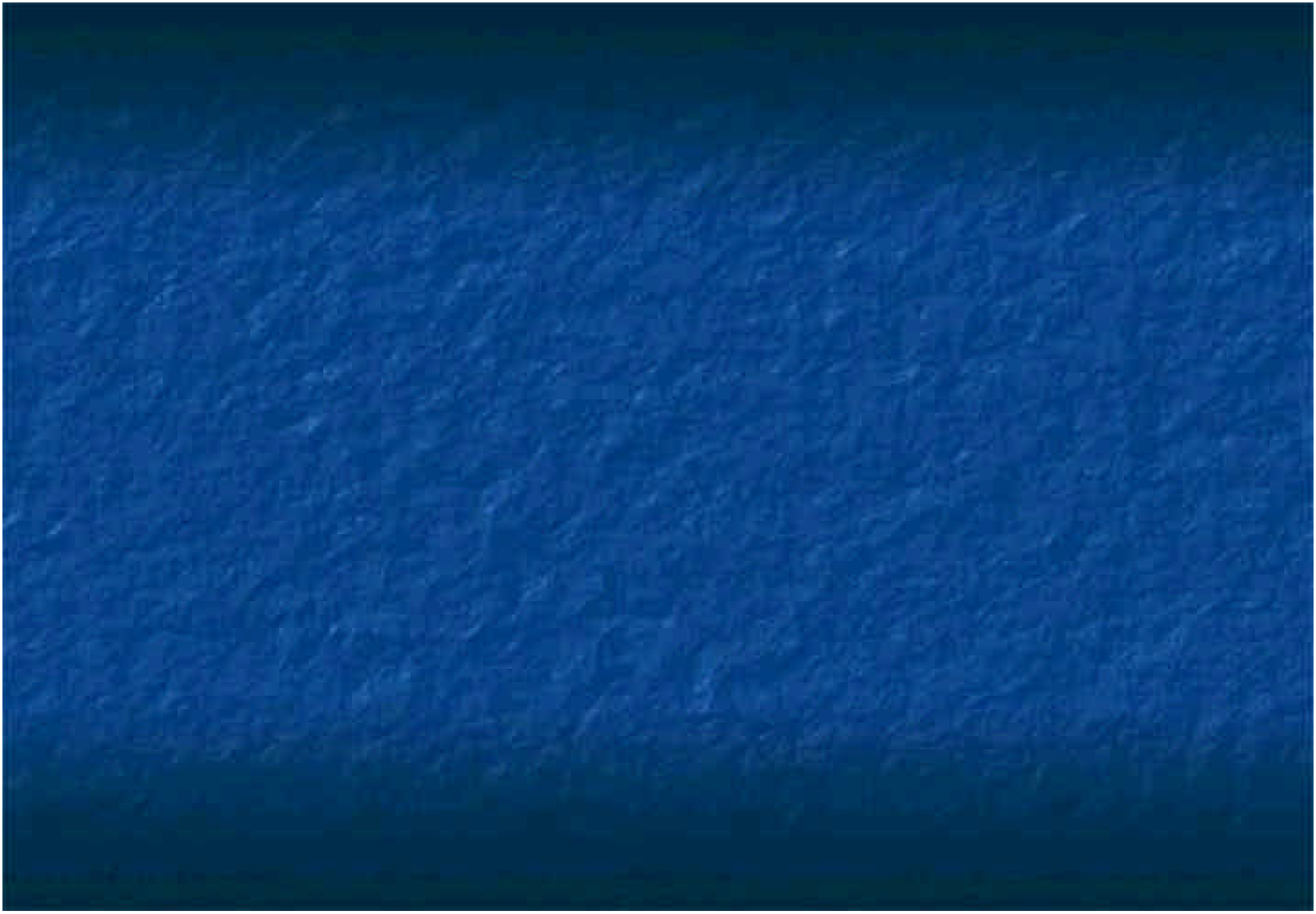
Data from non-prime detectors can be used to:

- Increase signal to noise
- Extend wavelength coverage
- Check uncertain features
- Improve calibration

Other long LWS Fabry-Perot datasets:

Orion - 26 observations
Sgr A - 25 observations
Jupiter – 25 observations
Saturn – 22 observations

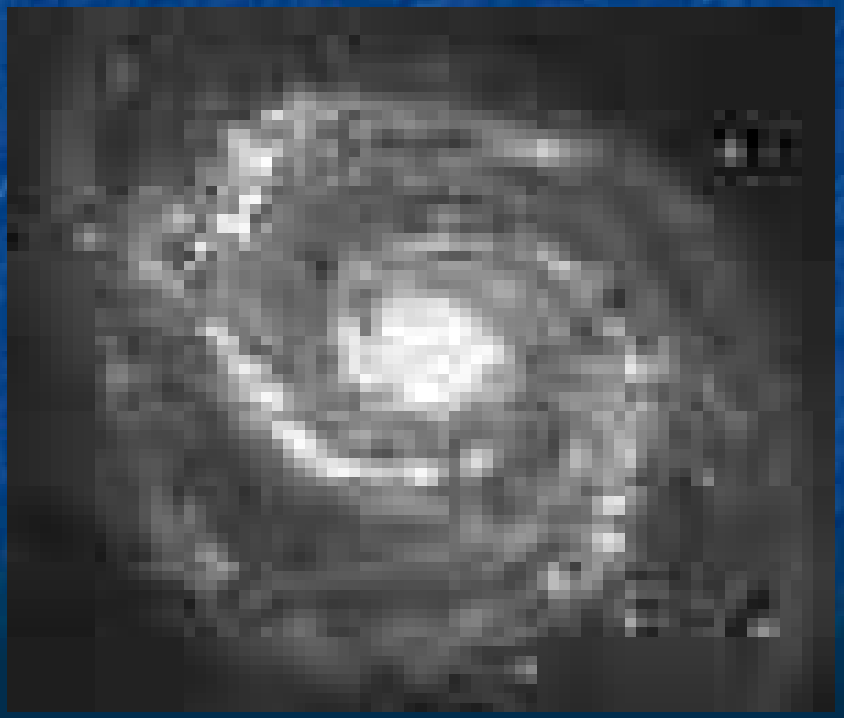


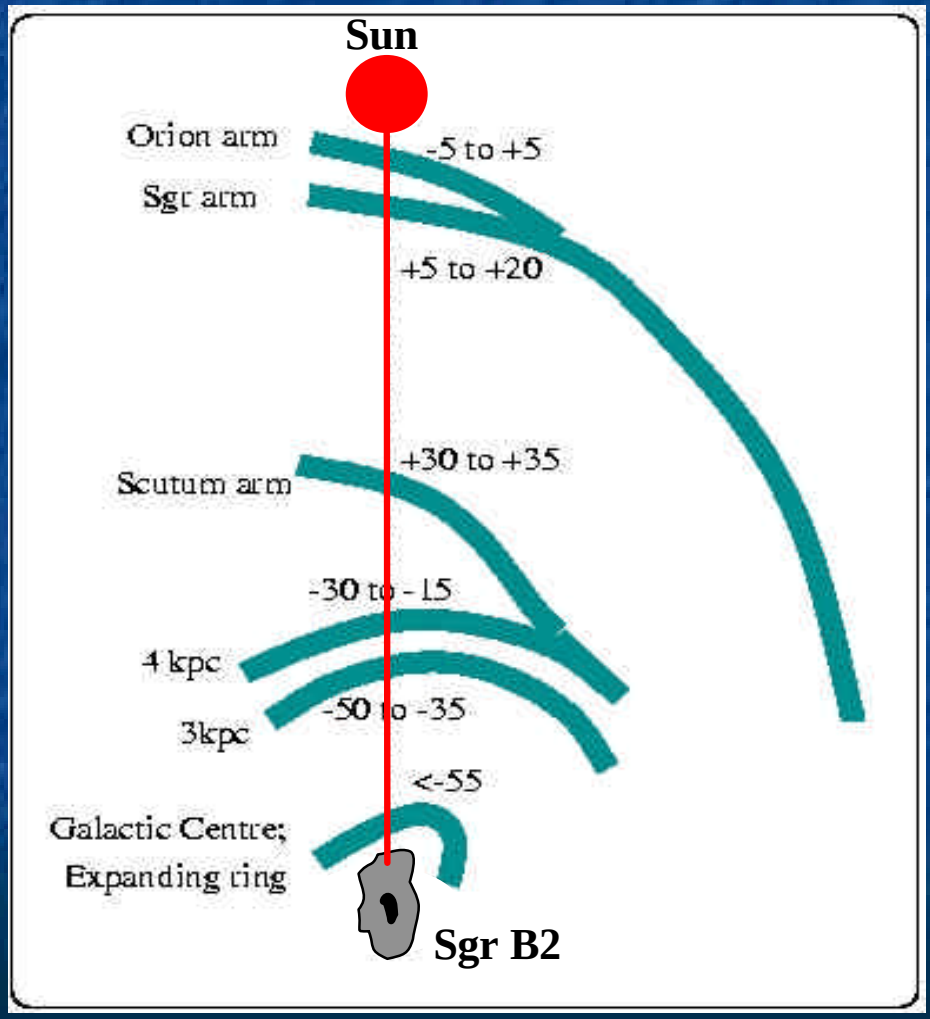


Galactic spiral arms in the line of sight

Velocity range of Galactic spiral arms:

-100 γ +30 km s^{-1}





(adapted from Greaves & Williams 1994)

16OH 17OH 18OH

- Ground state rotational transitions are observed from ^{16}OH, ^{17}OH and ^{18}OH.
- Higher rotational levels are observed from ^{16}OH in Sgr B2 itself.
- These lines can be modelled to determine the oxygen isotopic gradient through the galaxy.