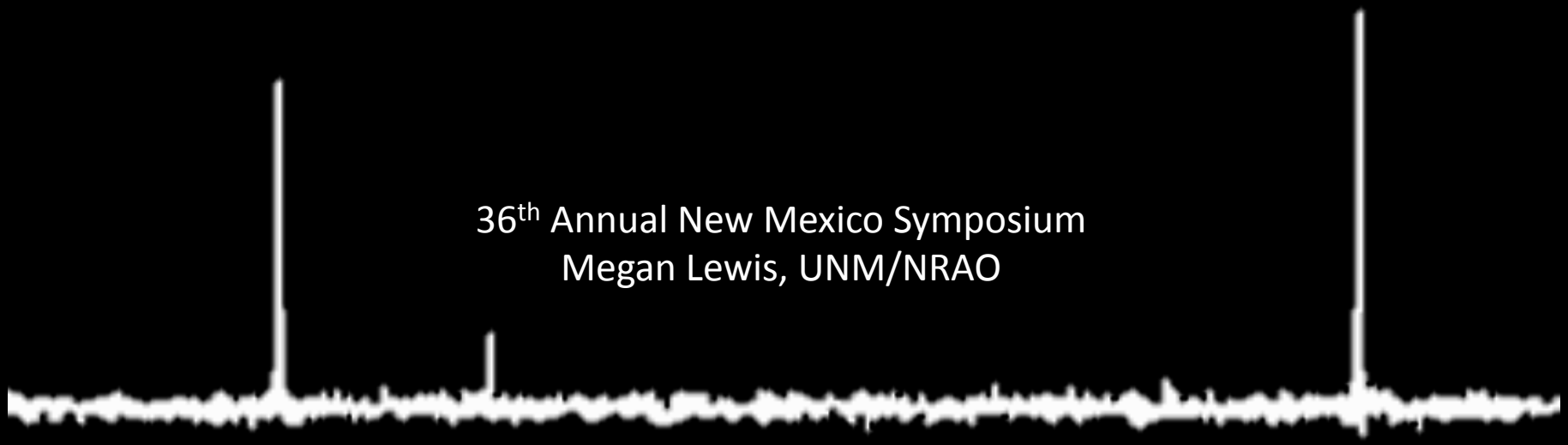
Using SiO masers to probe the evolved stellar population in the MW

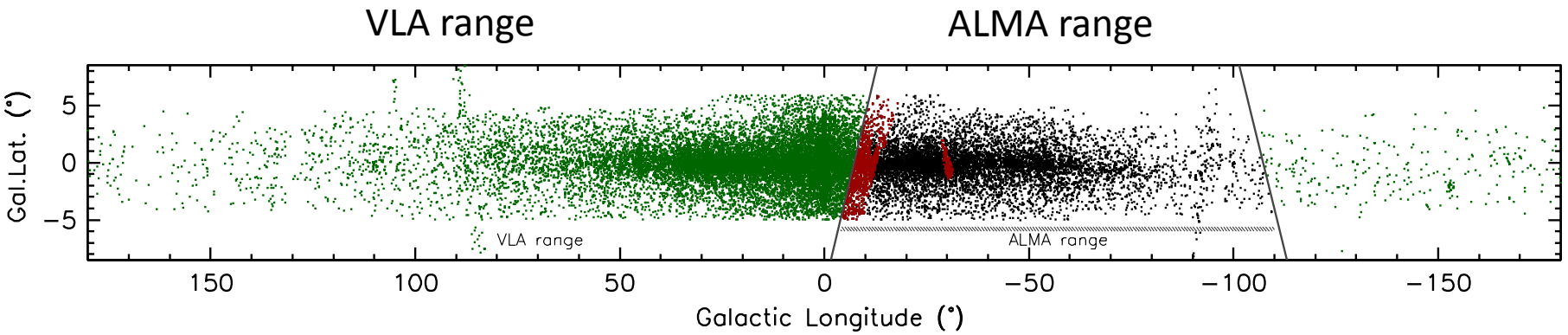


36th Annual New Mexico Symposium
Megan Lewis, UNM/NRAO

with: Ylva Pihlström, Loránt Sjouwerman, Luis Henry Quiroga-Nuñez, Brandon Medina, Michael Stroh

Bulge Asymmetries and Dynamical Evolution

SiO maser survey of the Galactic Plane

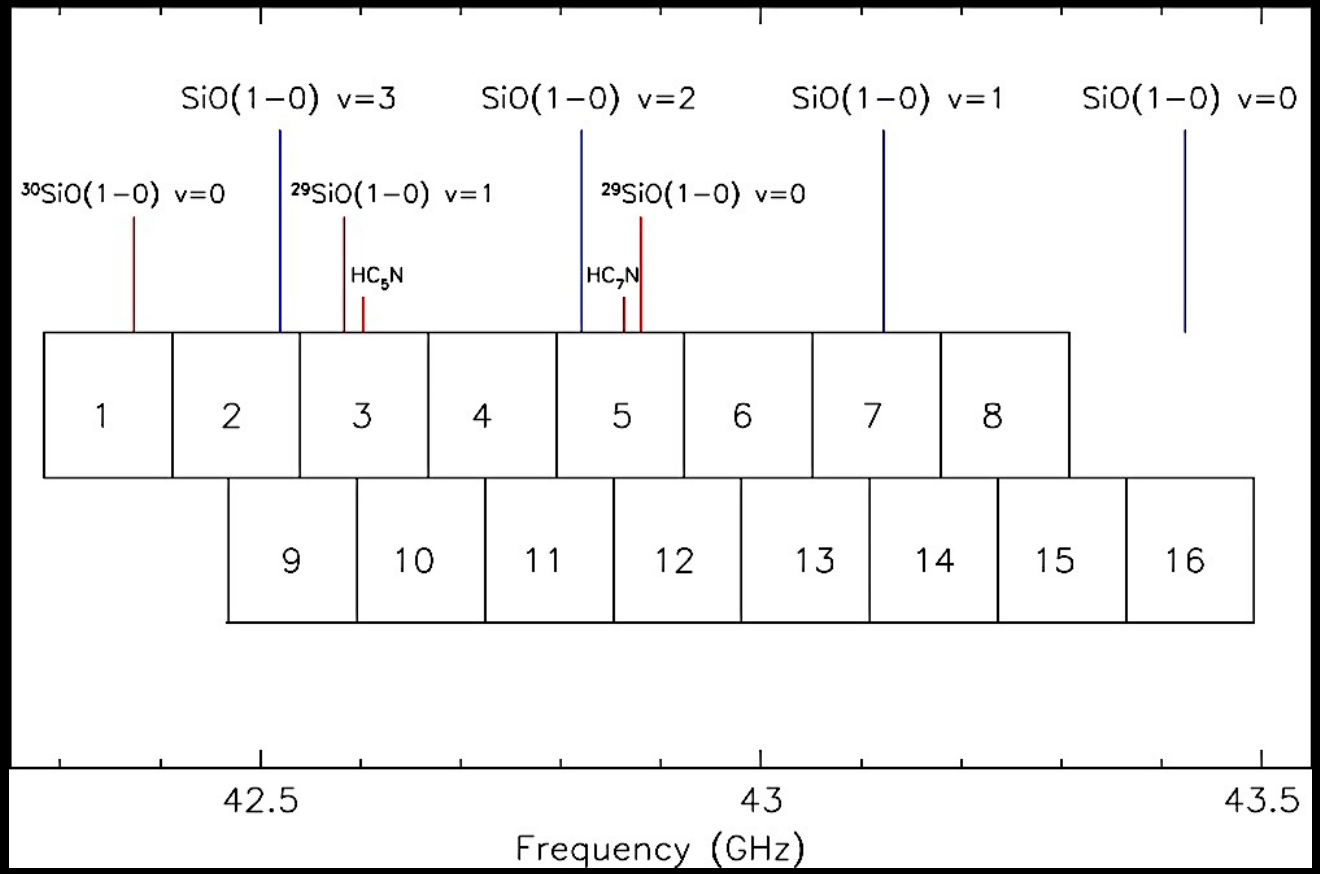


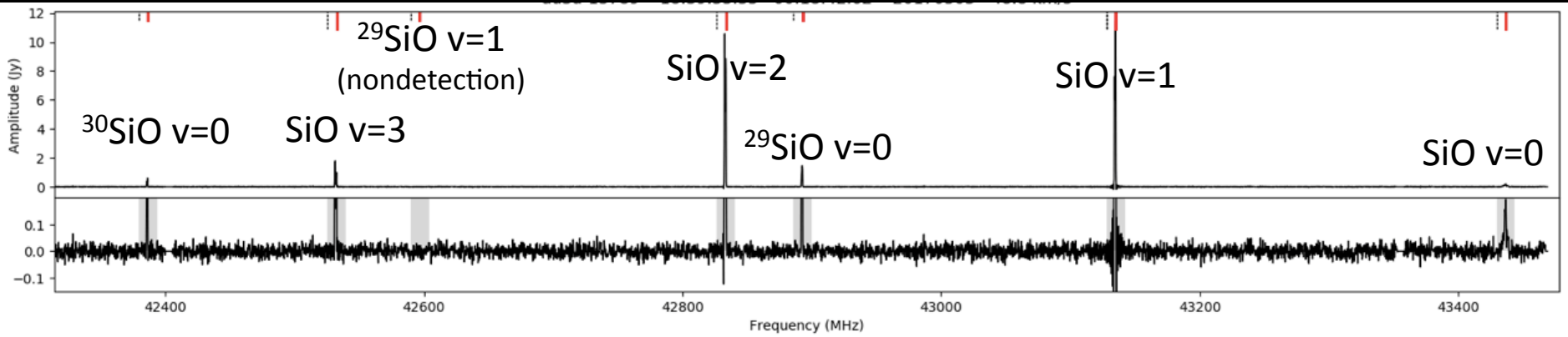
- Select likely thin-shelled AGB (Asymptotic Giant Branch) sources from IR catalogues
- Observe at radio frequencies
- Obtain spectra
- Extract maser properties

BAaDE Goals

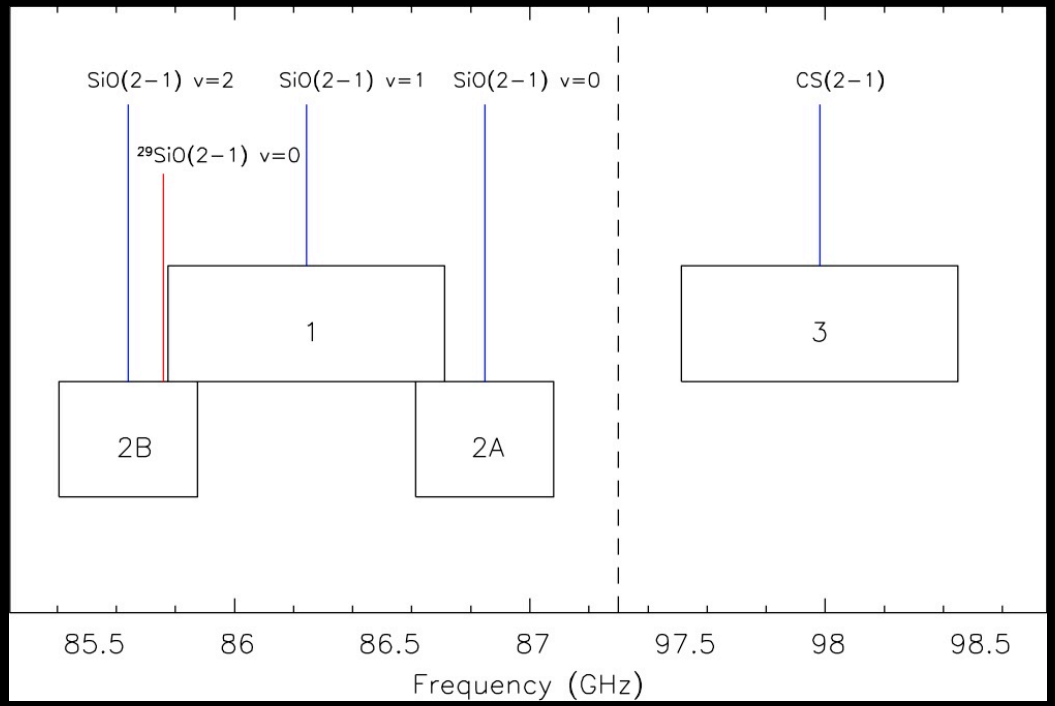
- Dynamics
  - Closer to the Plane than optical or IR
  - Traces older population
    - More info on Bulge less on spiral arms
- Red Galactic populations
  - Understand contents of the survey
  - Improve IR-color limits on stars that host SiO masers
- SiO maser behavior
  - Collection of line ratios to compare to models
    - First statistical collection of isotopologue detections
  - huge sample to examine trends in line-ratios and colors

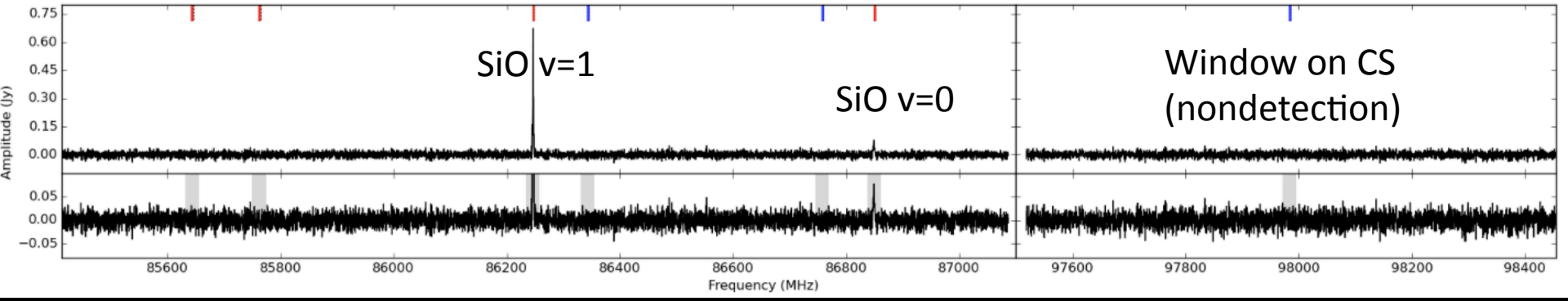
VLA


SiO(1−0) v=3
SiO(1−0) v=2
SiO(1−0) v=1
SiO(1−0) v=0
30SiO(1−0) v=0
29SiO(1−0) v=1
29SiO(1−0) v=0
HC5N
HC7N
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
42.5
43
43.5
Frequency (GHz)


29SiO v=1
(nondetection)
SiO v=2
SiO v=1
30SiO v=0
SiO v=3
29SiO v=0
SiO v=0
Amplitude (Jy)
Frequency (MHz)

ALMA


SiO(2−1) v=2
SiO(2−1) v=1
SiO(2−1) v=0
CS(2−1)
29SiO(2−1) v=0
1
3
2B
2A
85.5
86
86.5
87
97.5
98
98.5
Frequency (GHz)


SiO v=1
SiO v=0
Window on CS
(nondetection)
Amplitude (Jy)
0.75
0.60
0.45
0.30
0.15
0.00
0.05
0.00
−0.05
85600
85800
86000
86200
86400
86600
86800
87000
97600
97800
98000
98200
98400
Frequency (MHz)

Color-color trends

- Constrain regions of IR color-color diagrams where SiO masers are found (O-rich AGBs)
- Other studies: 20-100 sources identified previously in the literature
- BAaDE: thousands of sources with (limited) spectroscopy
  - Can id O-rich AGBs from SiO maser detections
  - Infer other types of sources from areas of very low detection rates
- Targeted follow-up

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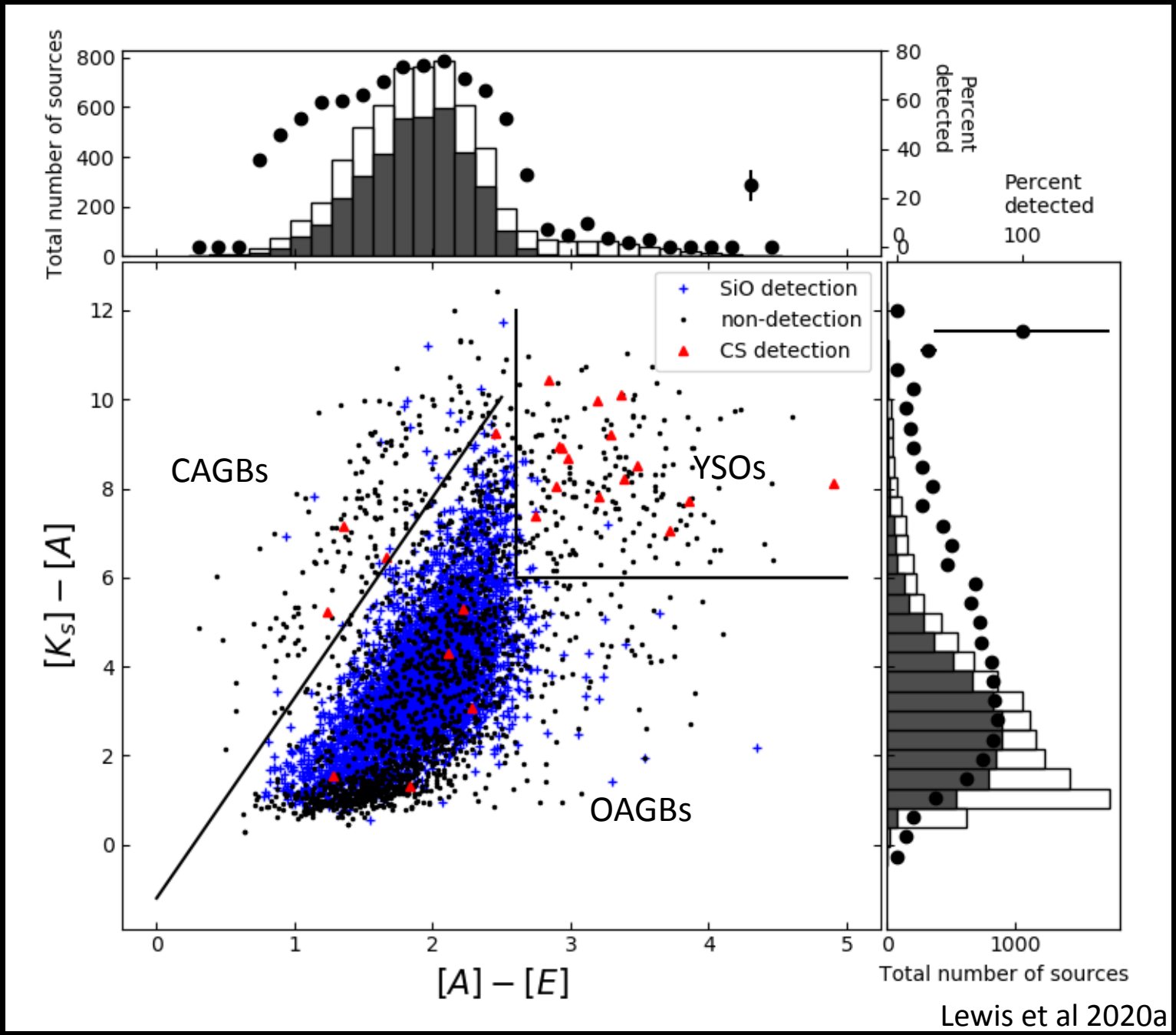
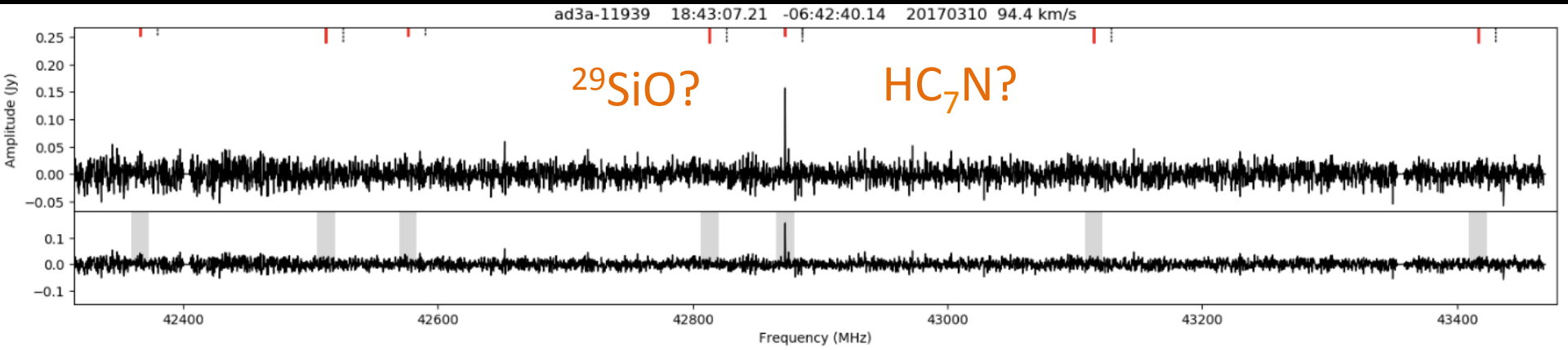
BAaDE color-color

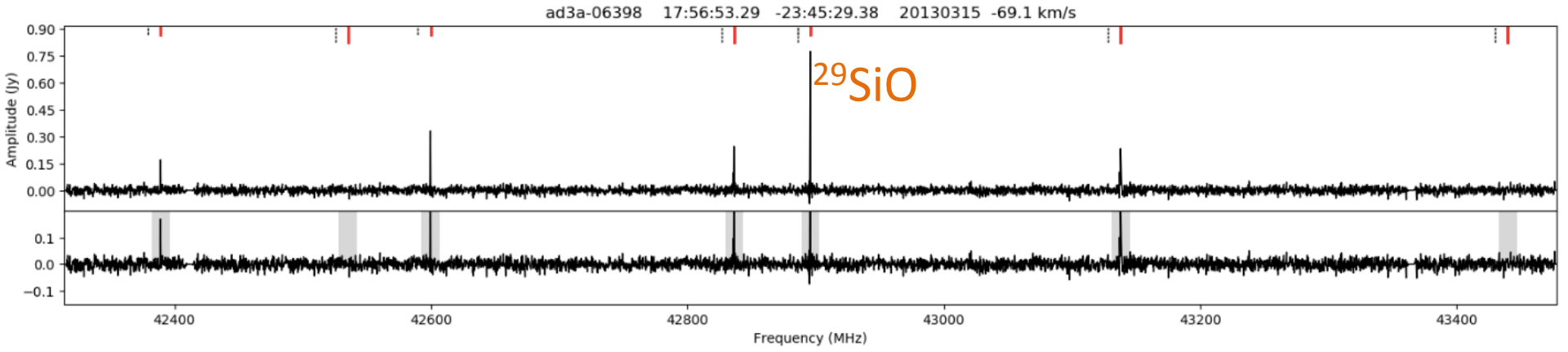


K_s : 2.2 µm
A: 8 µm
E: 21 µm

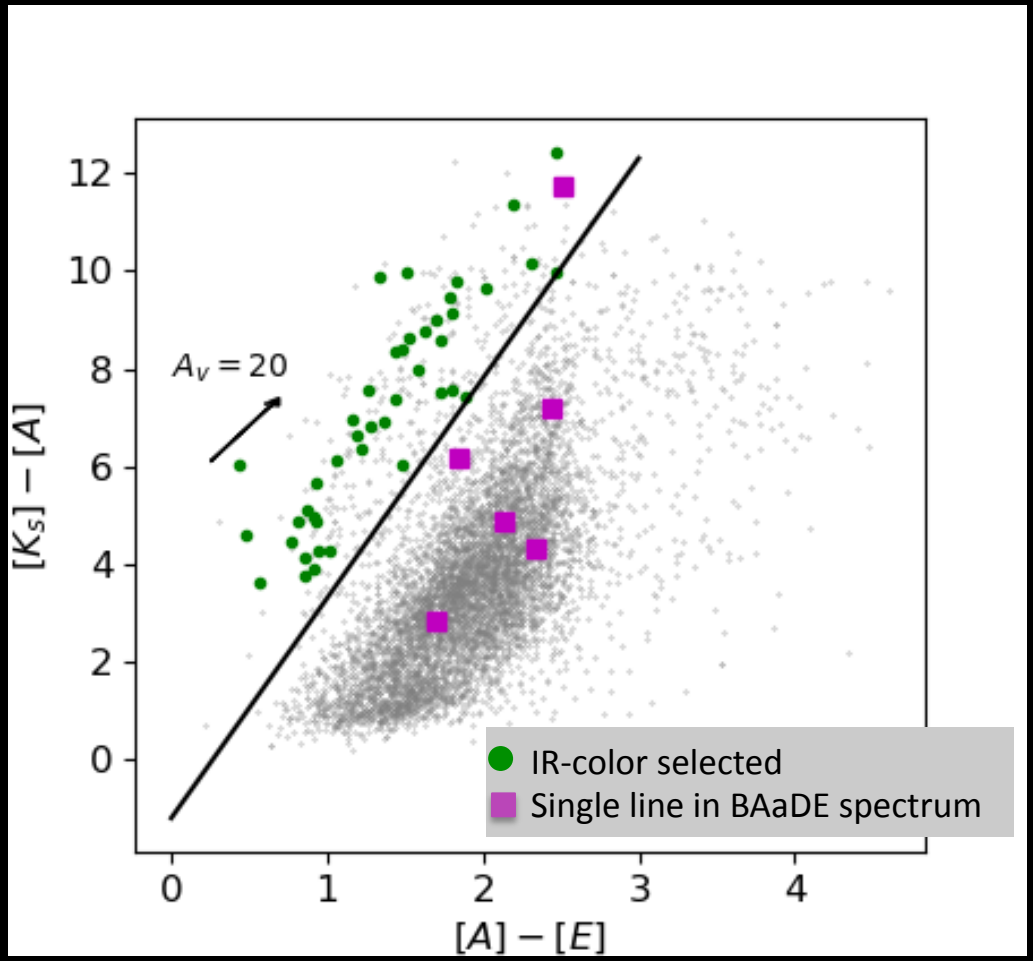
Lewis et al 2020a

Single-line detections





New (sub)sample



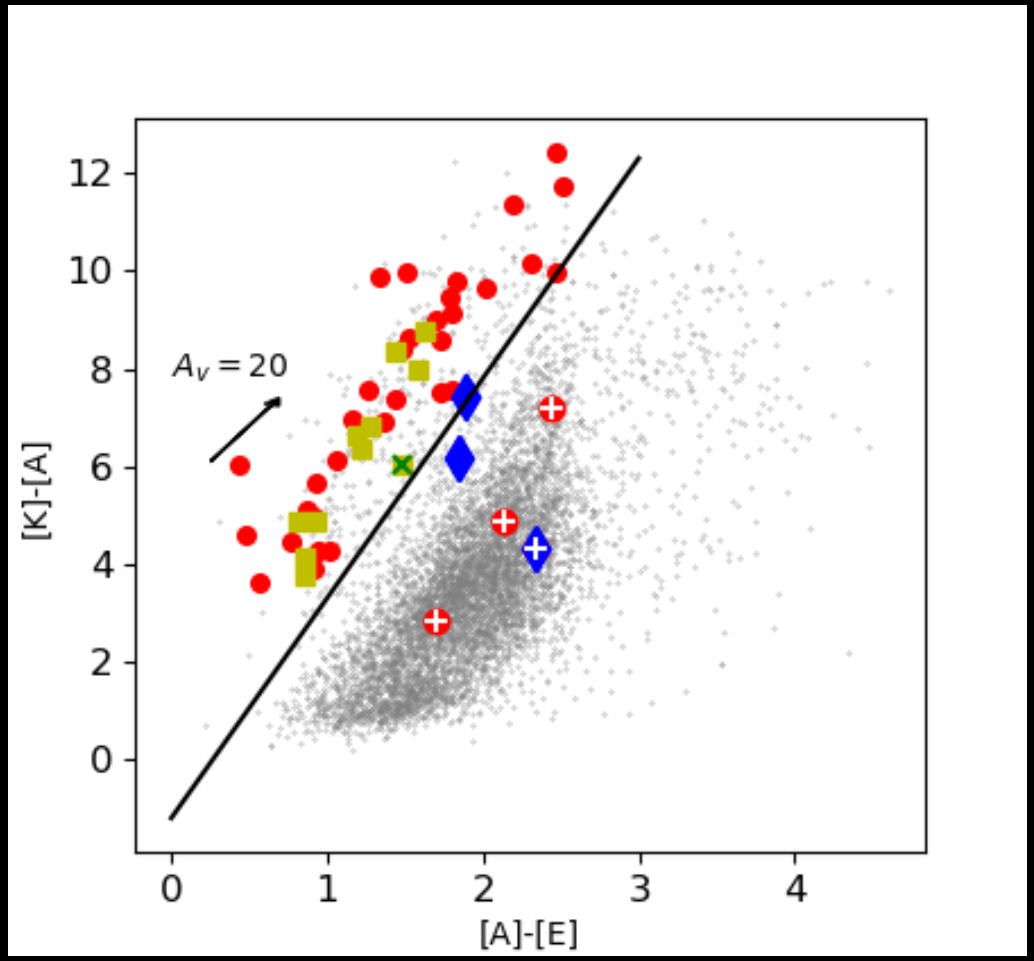
51 BAaDE sources,
14 with useful IRAS low-resolution spectra

Deeper integration/better sensitivity

Goal: new detections that will test C-rich region and identify single-lines

Lewis et al. 2020b

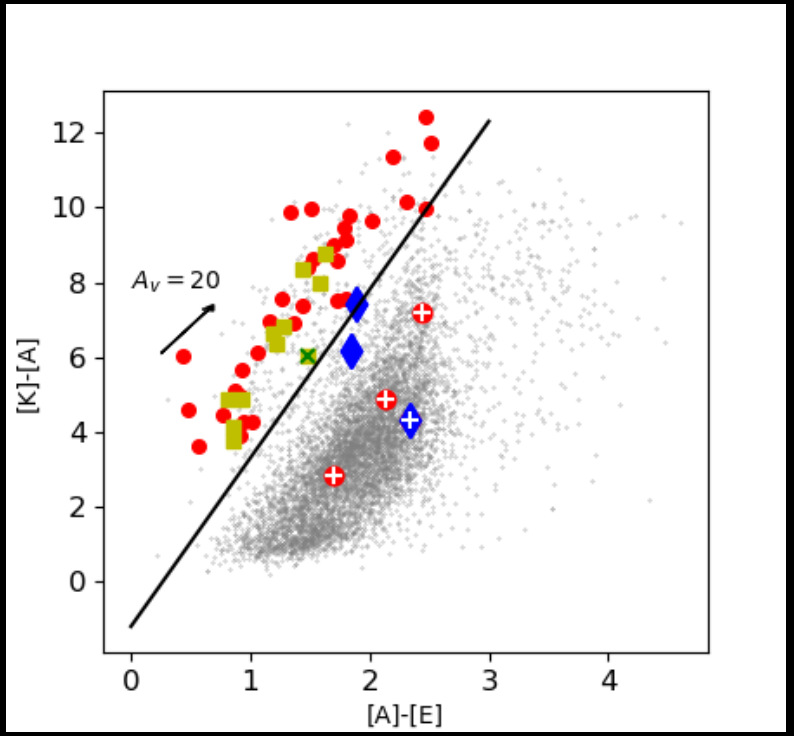
New detections



No useful IRAS id
C-rich IRAS LRS
O-rich IRAS LRS
SiO detection
HC_3N detection

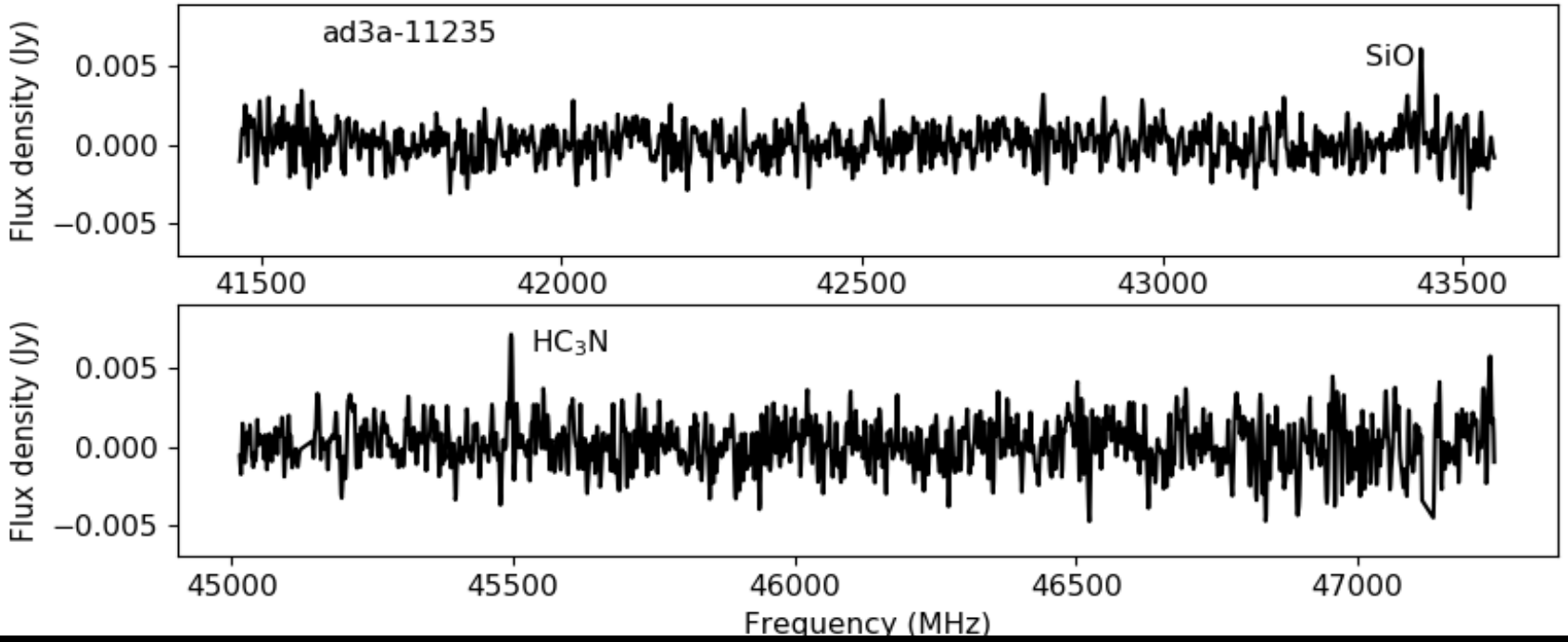
Lewis et al. 2020b

- Detection rate in O-rich AGB region* is 79% which is very similar to detection rate expected in a sample of maser-hosts given variability
- Hundreds of C-rich bulge candidates (need distances!)



*Given a few extra cuts to keep the sample homogenous and exclude really thin-shell sources

Details of new detections



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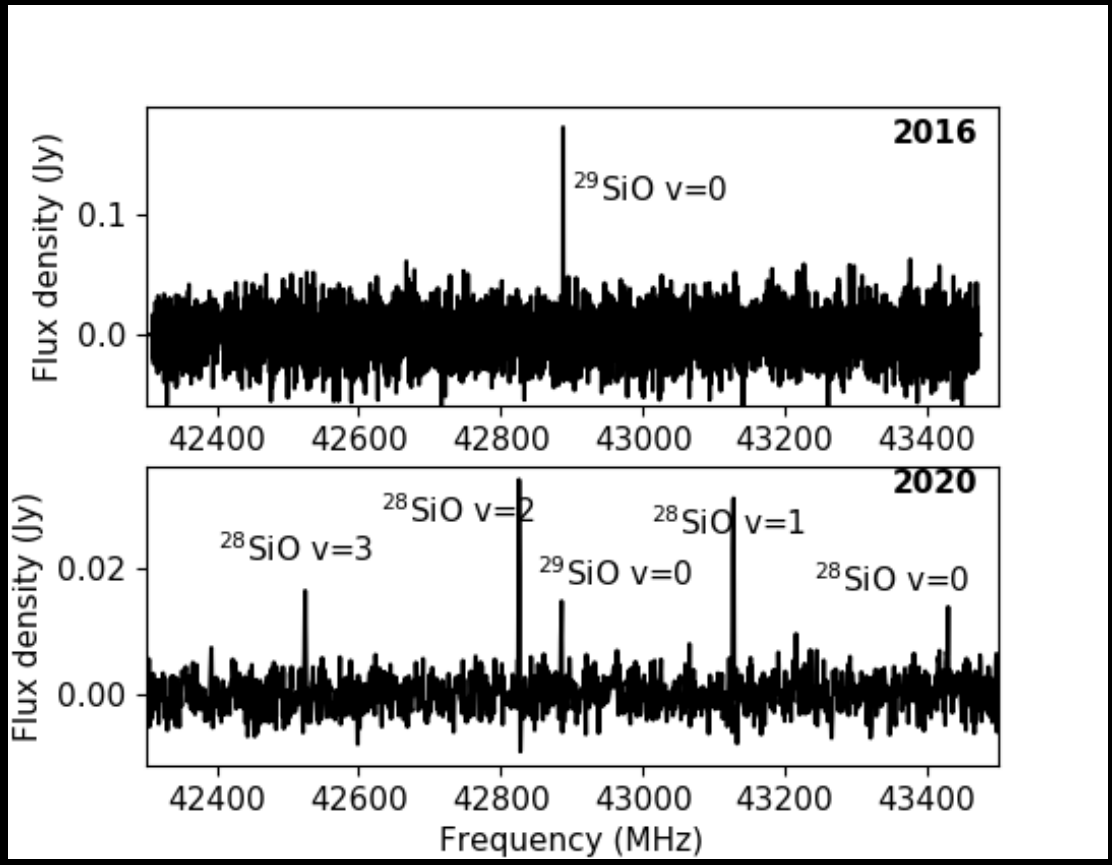
Details of new detections

Time variable "isotopologue dominated" spectra

One extra bit of info on these strange sources: their atypical line ratios can change to typical over years

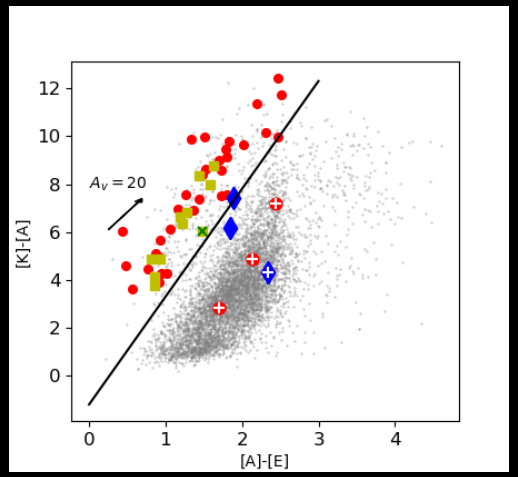


Lewis et al. 2020b

Conclusions

BAaDE and follow-ups allowed for solidly established IR-color cut between O- and C-rich AGB stars

- Detection rate among O-rich sources 79%
- Effective way to find C-rich AGB stars in bulge if distances are known



Isotopologue dominated sources are rare but BAaDE data reveals several

- Line ratios change and even flip over time
- Cause of bright isotopologue lines unknown