Radio Astronomy Projects in the Spanish VO

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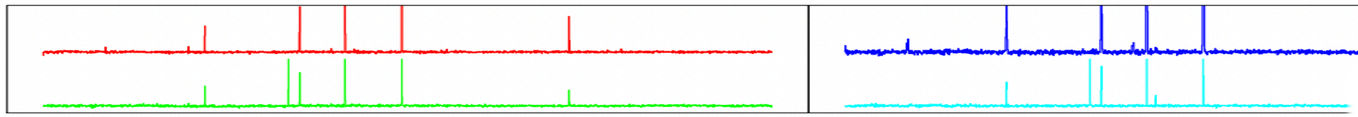
Spanish Virtual Observatory

Centro de Astrobiología

IVOA Interop Meeting

May 2021

- Aim: to facilitate smooth integration of Radio Astronomy products (surveys, archives) into VO
- Kickoff: A SiO survey
- Our own product: integration of MADCUBA outputs
- Other actions



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SiO, ^{29}SiO, and ^{30}SiO Emission from 67 Oxygen-rich Stars: A Survey of 61 Maser Lines from 7 to 1 mm

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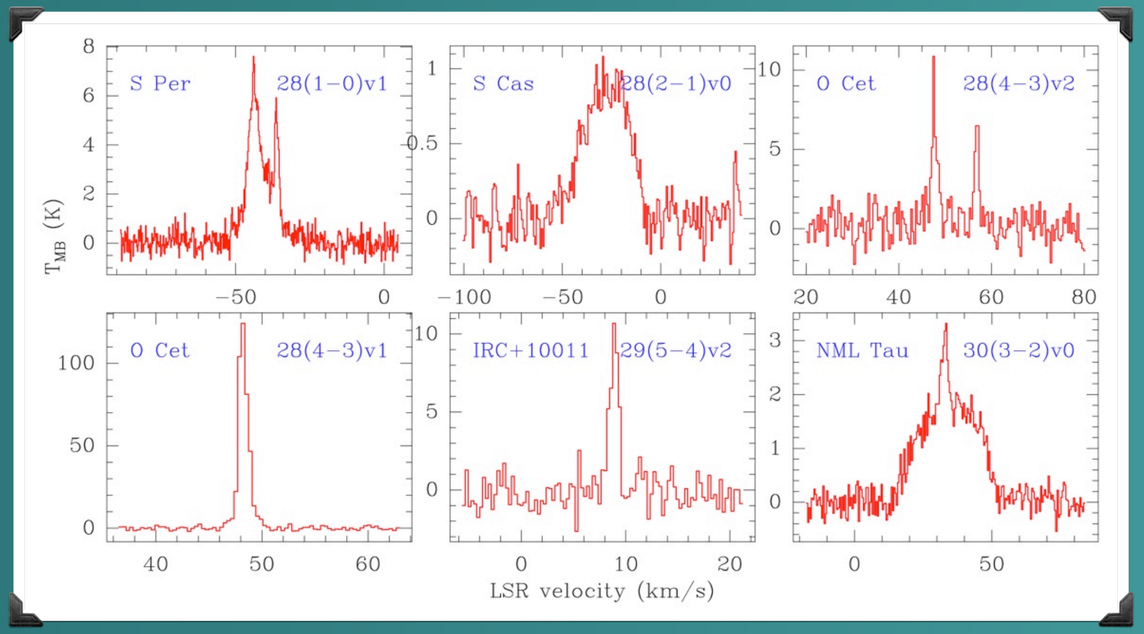
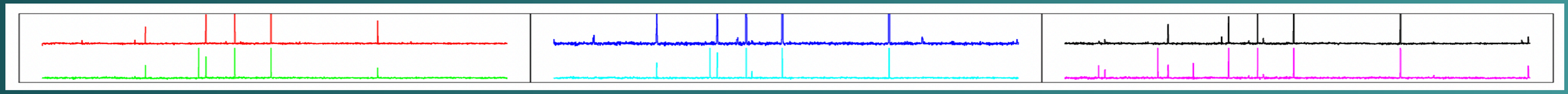
Abstract

Circumstellar environments of oxygen-rich stars are among the strongest SiO maser emitters. Physical processes such as collisions, infrared pumping, and overlaps favor the inversion of level population and produce maser emission at different vibrational states. Despite numerous observational and theoretical efforts, we still do not have a unified picture including all of the physical processes involved in SiO maser emission. The aim of this work is to provide homogeneous data in a large sample of oxygen-rich stars. We present a survey of 67 oxygen-rich stars

The science

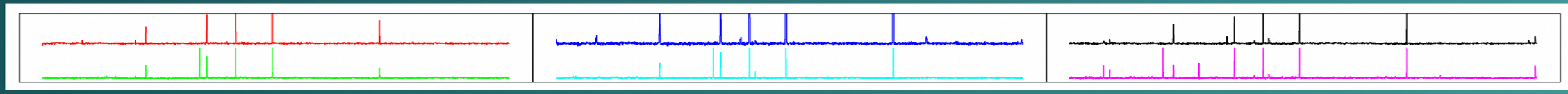
- Survey of SiO maser emission in oxygen-rich stars
- Wavelength from 7mm to 1mm
- NASA DSS-54 and IRAM 30m antennas
- Sensitive and probably the most complete to date
- Different bandwidths and polarizations
- Citation: Rizzo et al. 2021, ApJS 253, 44





The numbers

- **3** isotopologs: ^{28}SiO, ^{29}SiO, ^{30}SiO
- **5** rotational lines: J=1→0 to 5→4
- **Up to 6** vibrational numbers: v=0 to v=6
- **61** different maser lines
- **2** radio telescopes: NASA DSS-54, IRAM 30m
- **2** polarizations: circular and linear
- **5** bandwidths: from 100 MHz to 8 GHz
- **67** stars
- **4000+** individual spectra
- **At least 27** bonus thermal lines



The VO service

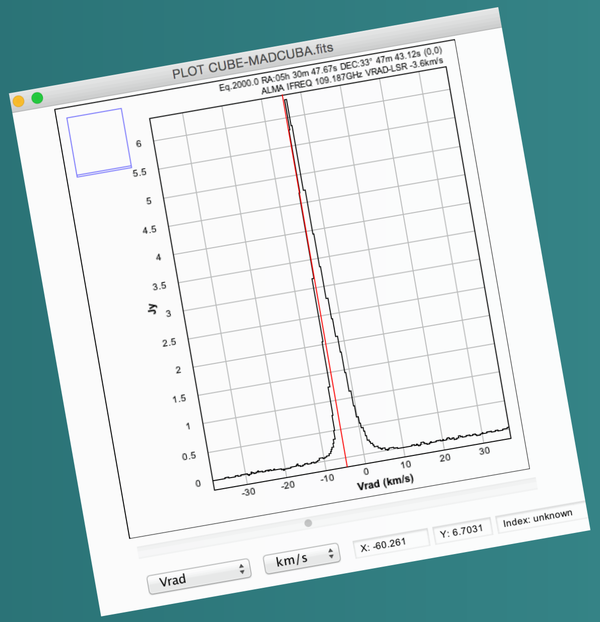
- Small to mid-size catalog
- Conceived as a template for other single-dish spectroscopic surveys
- Based on SVOCat
- Registered. Hosted at SVO
- Available at:

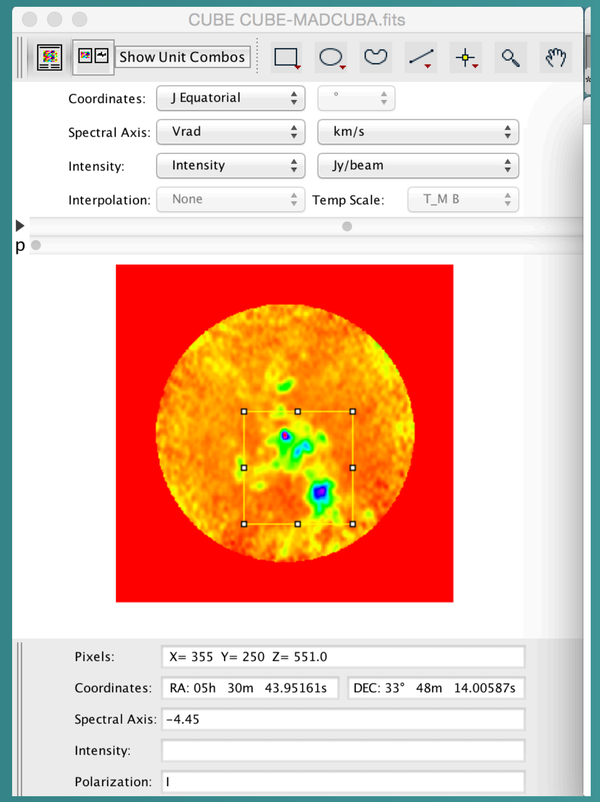
http://svo2.cab.inta-csic.es/vocats/sio

- Data can be retrieved by several parameters:
  - Cone search
  - Source name
  - Central frequency
  - Telescope / Receiver
  - Frequency range
- FITS (GILDAS-style) and PNG preview available
- Short description and references included

Features

- Suite aimed to deal with large data cubes
- Based on imageJ infrastructure (e.g. Java)
- Able to read several data models (IRAM, ALMA, Herschel, VLA, GBT, and others)
- Built-in or online access to molecular line databases (CDMS, JPL, others)
- Visualize and manipulate data cubes
- Analyze spectral lines (both 1-pix and cube)

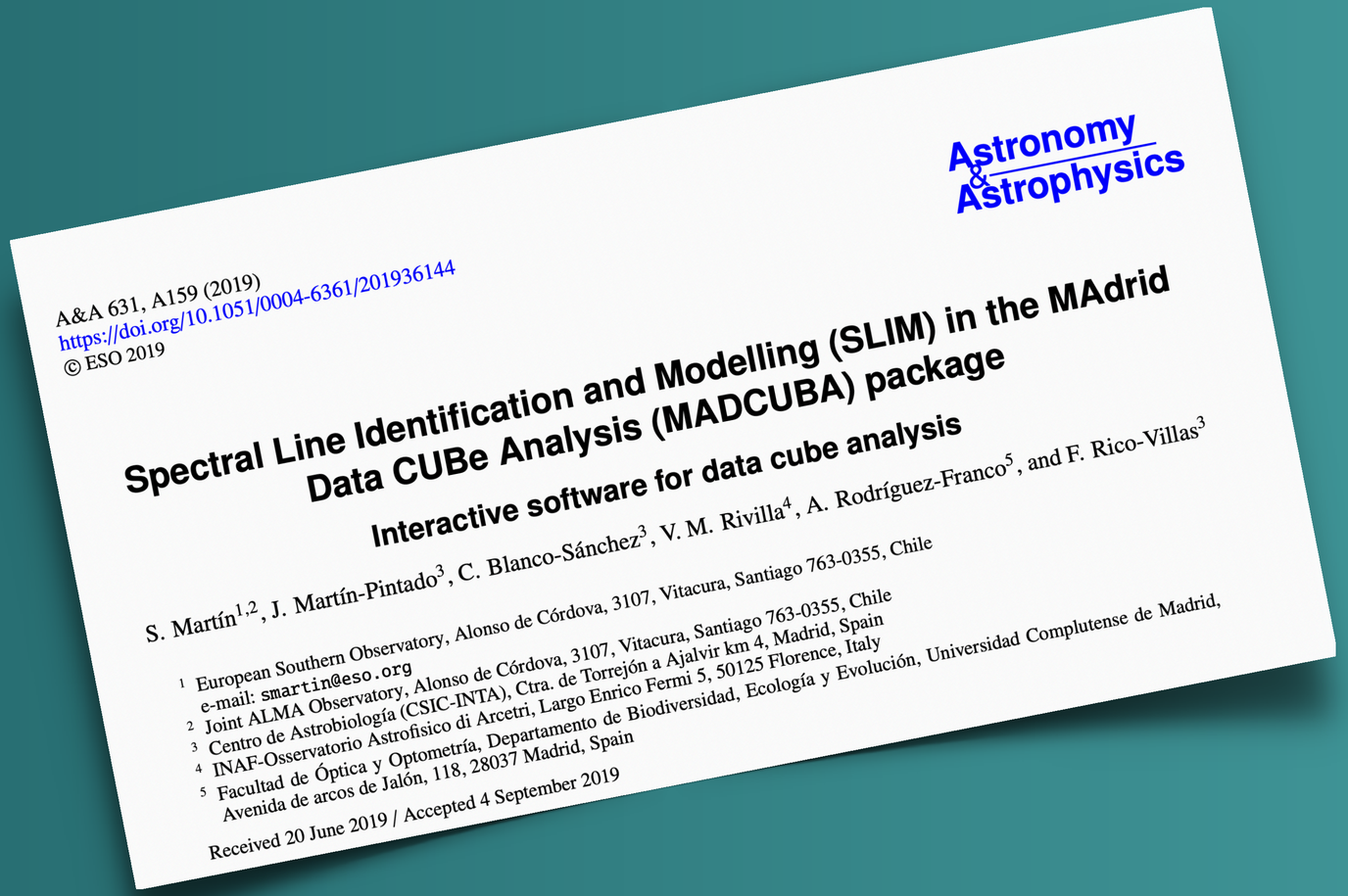




Features

- Identify molecular species
- Derive line parameters
- LTE and non-LTE fitting (1px & cube)
- Autofitting (LVG; χ^2 method)
- Hosted and supported by CAB
- Available at:

https://cab.inta-csic.es/madcuba/



A&A 631, A159 (2019)
https://doi.org/10.1051/0004-6361/201936144

Astronomy & Astrophysics

Spectral Line Identification and Modelling (SLIM) in the MAdrid Data CUBe Analysis (MADCUBA) package

Interactive software for data cube analysis

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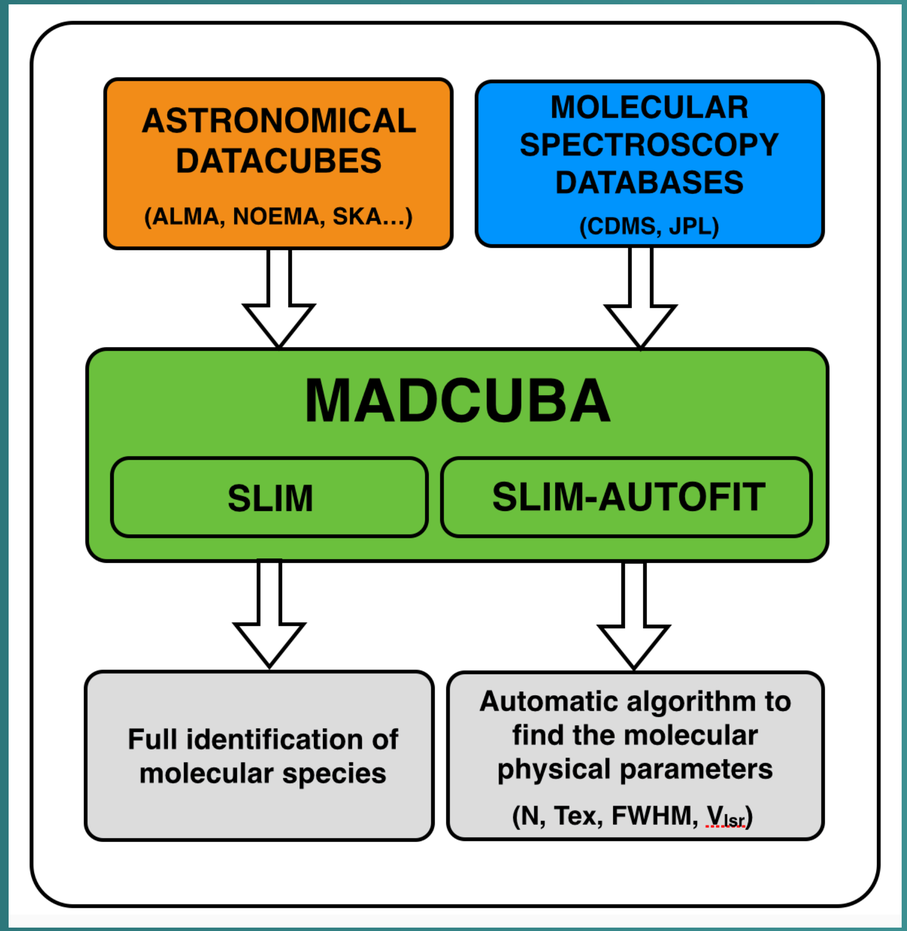
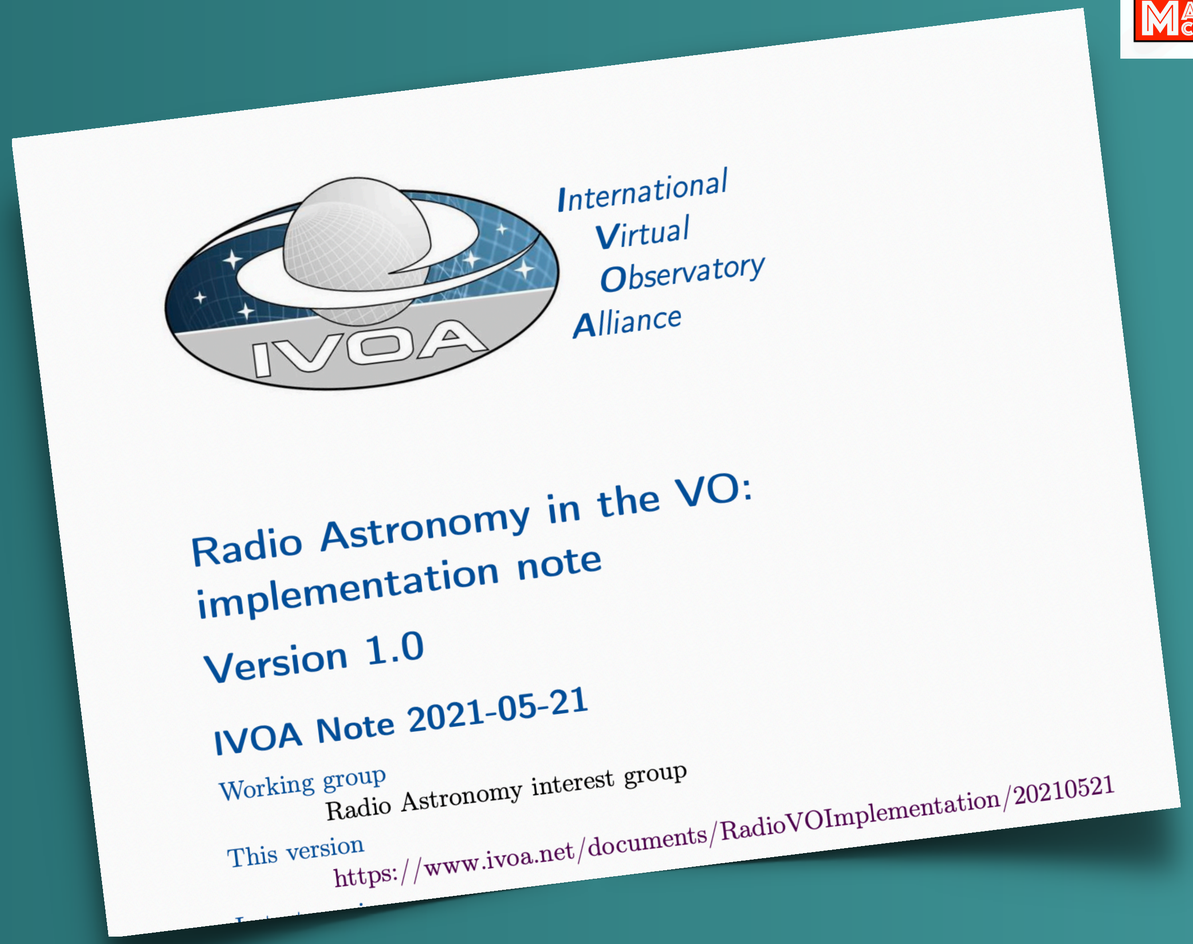
We will concentrate in:

- **SLIM**: tool to identify lines and derive physical parameters
  - LTE assumed
  - simultaneous multiple molecules
  - data cube as a whole
- **SLIM-AUTOFIT**: independent and best-fit determination of physical parameters
- **Output**:
  - Synthetic spectra & cubes
  - Residual from observations
  - Physical parameters with uncertainties



Possible approach:

- **Synthetic cubes (DAL services)**:
  - SIA2
  - other solutions? (CAOM, …)
- **Metadata**:
  - physical parameters using DataLink (still under study)
- **Residuals**:
  - yet undefined



We aim to:

- Take advantage of VO to increase **visibility** of radio astronomy to non-specialists
- Promote **smooth availability** of data from different radio observatories
- Contribute to incorporate **more** products (archives, catalogs, …)

We are:

- **Learning** a lot! Philosophy, protocols, solutions, …
- **Looking for** synergies and new collaborations
- **Working** on more line catalogs, MADCUBA, data access

Thank you!

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