ISMDB

InterStellar Medium DataBase

http://ism.obspm.fr

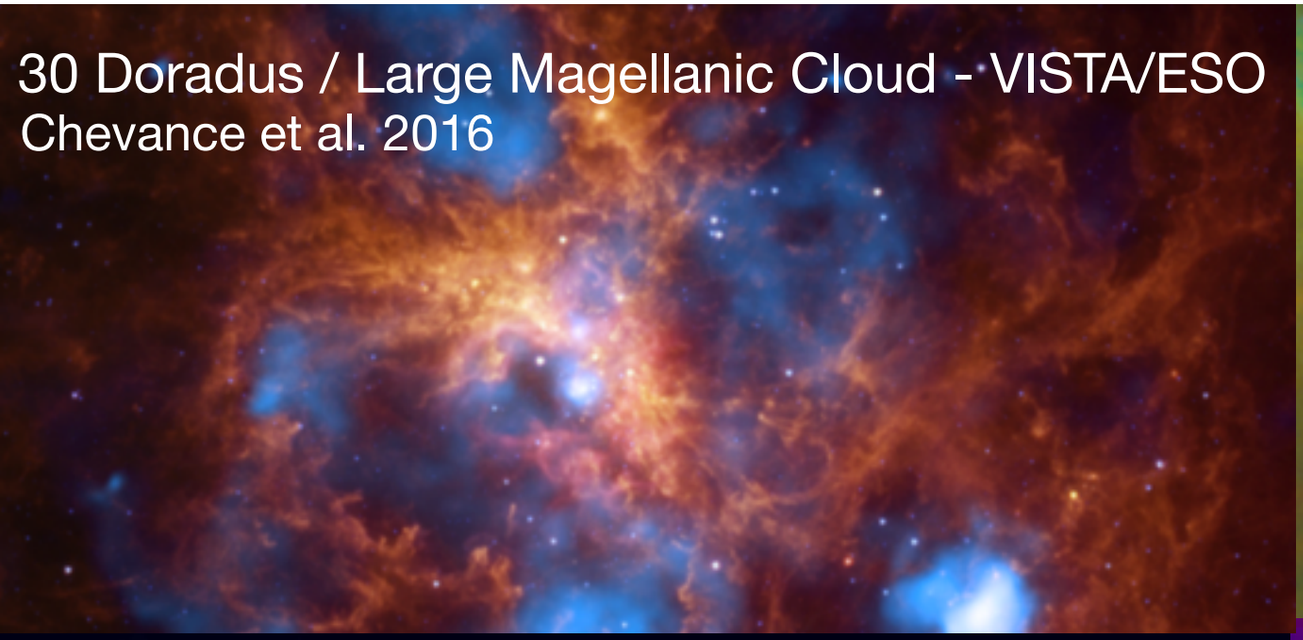
Franck Le Petit
David Languignon
Emeric Bron
Benjamin Godard

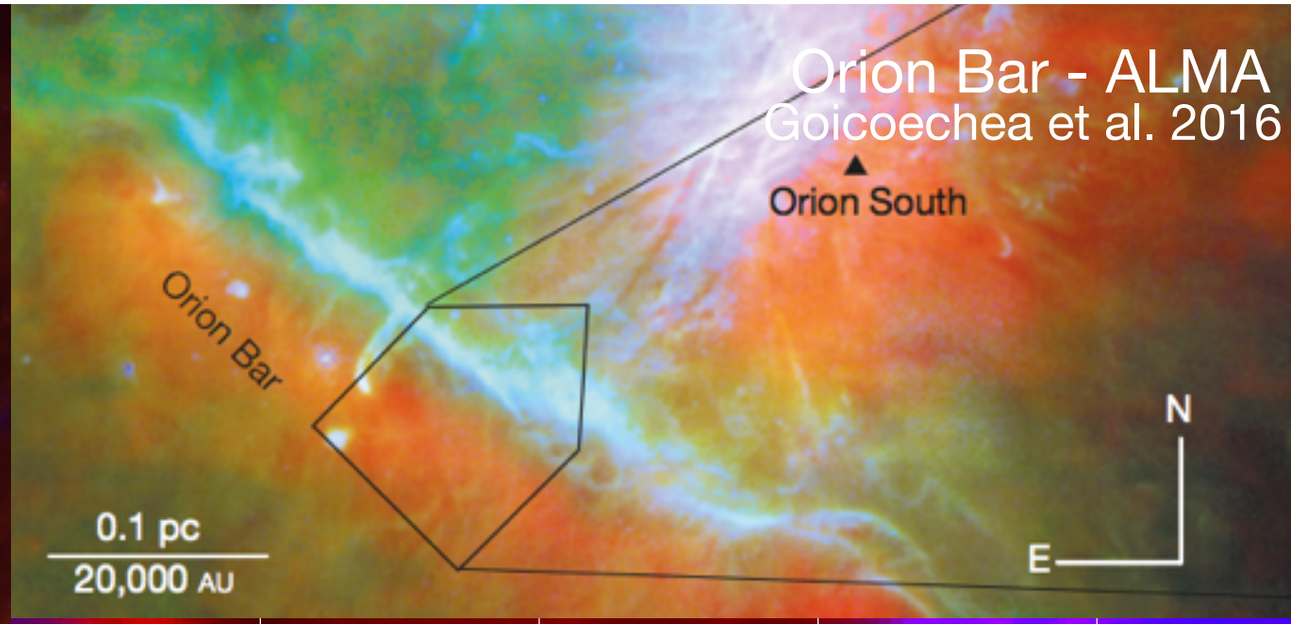
ASOV Meeting - 15 March 2017

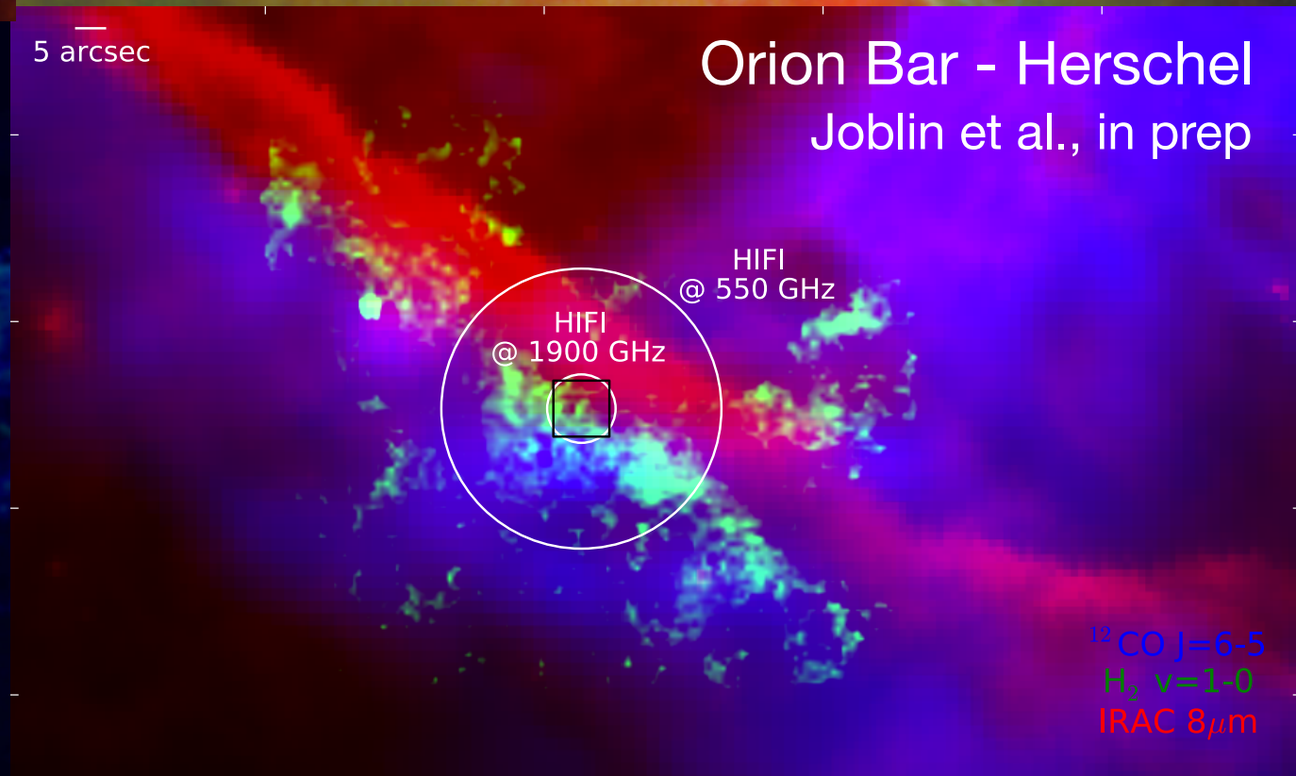
ISMDB

One of the services of the ANO5 "Plateforme MIS & Jets"

Goal: Provide services to prepare and interpret observations in Galactic & extragalactic interstellar medium







ISMDB

One of the services of the ANO5 "Plateforme MIS & Jets"

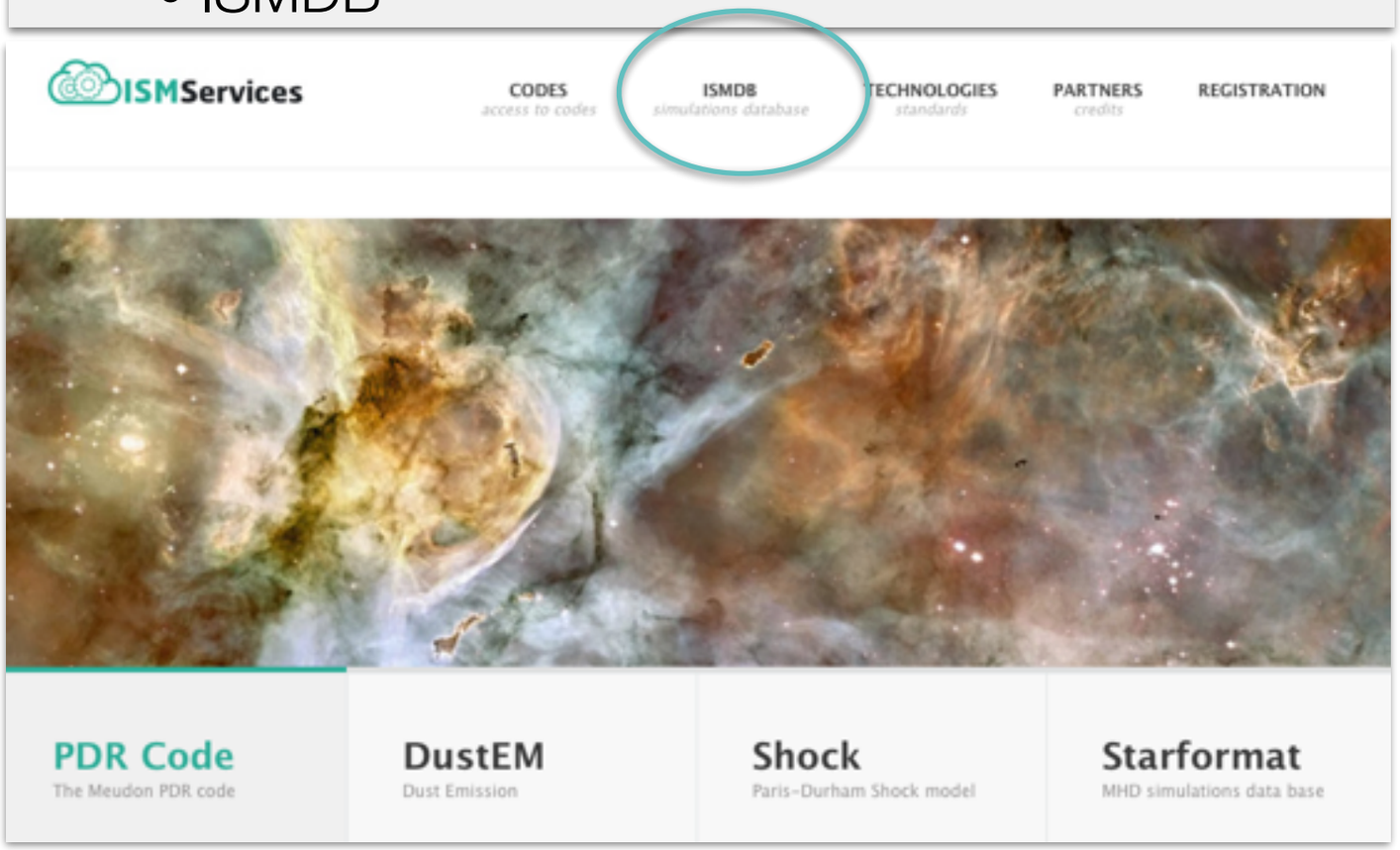
Goal: Provide services to prepare and interpret observations in the Galactic & extragalactic interstellar medium

Services are based on reference state-of-the-art codes

- PDR code
- Paris-Durham Shock code
- AMRVAC
- TDR code
- …

Several services are developed above the products of these codes

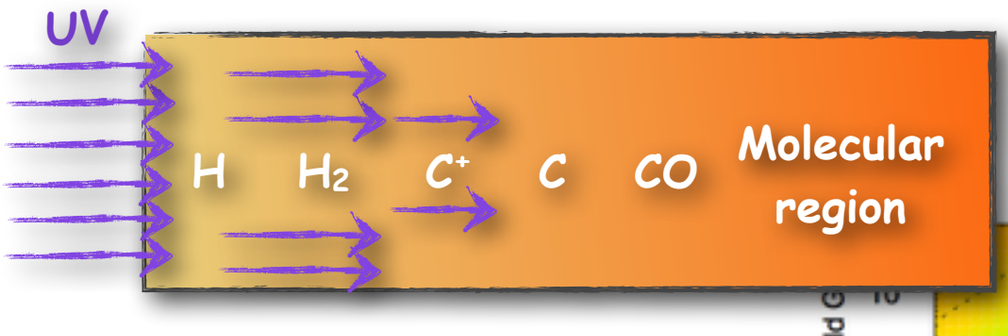
- Source codes & specific developments
- Online codes
- Tools to analyze results
  - Extractor & Chemistry Analyzer
- ISMDB

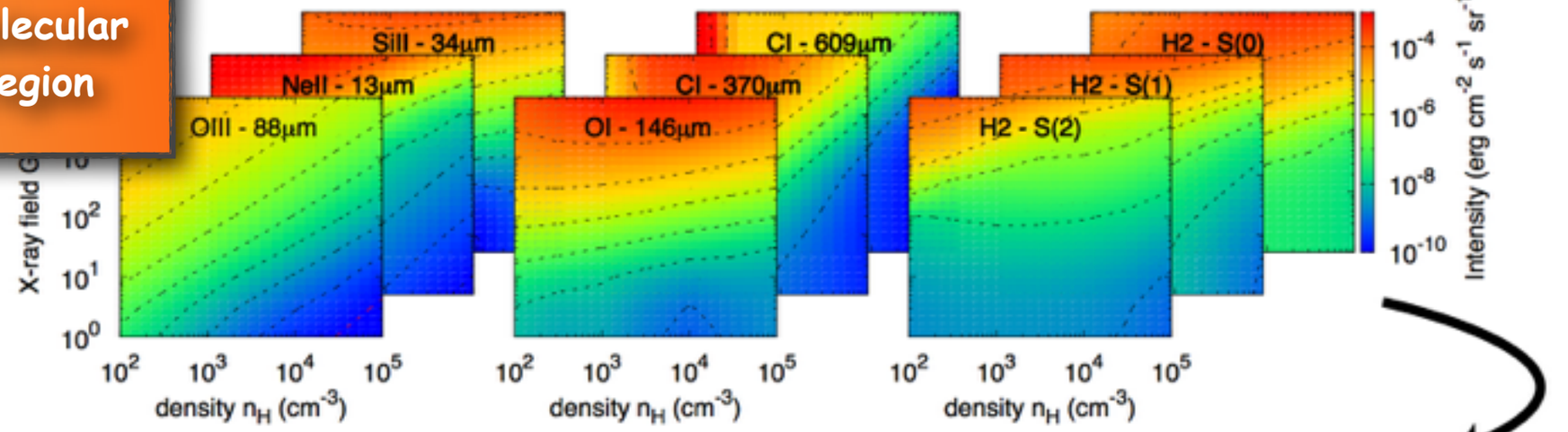


ISMDB

One of the services of the ANO5 "Plateforme MIS & Jets"

<u>Goal</u>: Provide services to prepare and interpret observations in Galactic & extragalactic interstellar medium

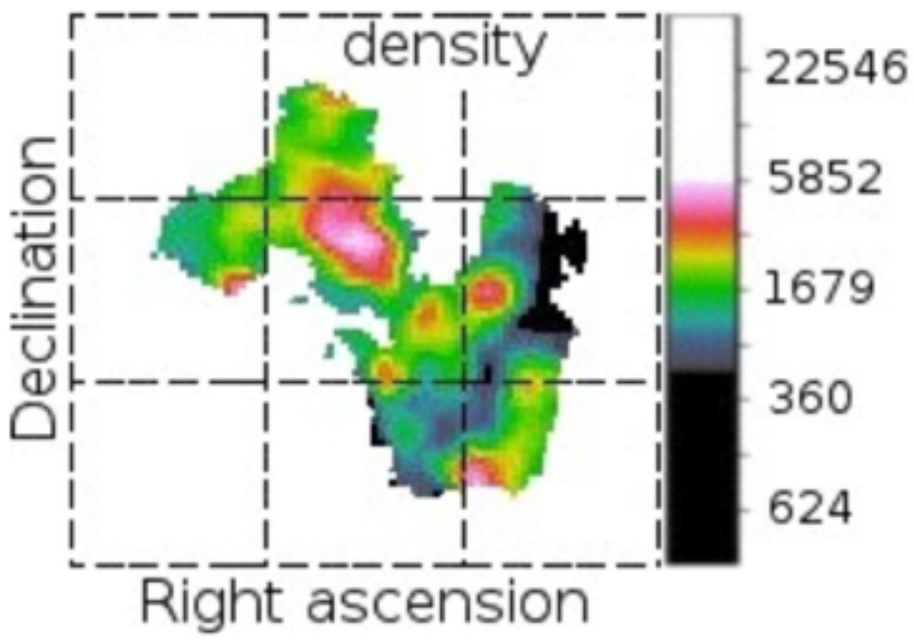


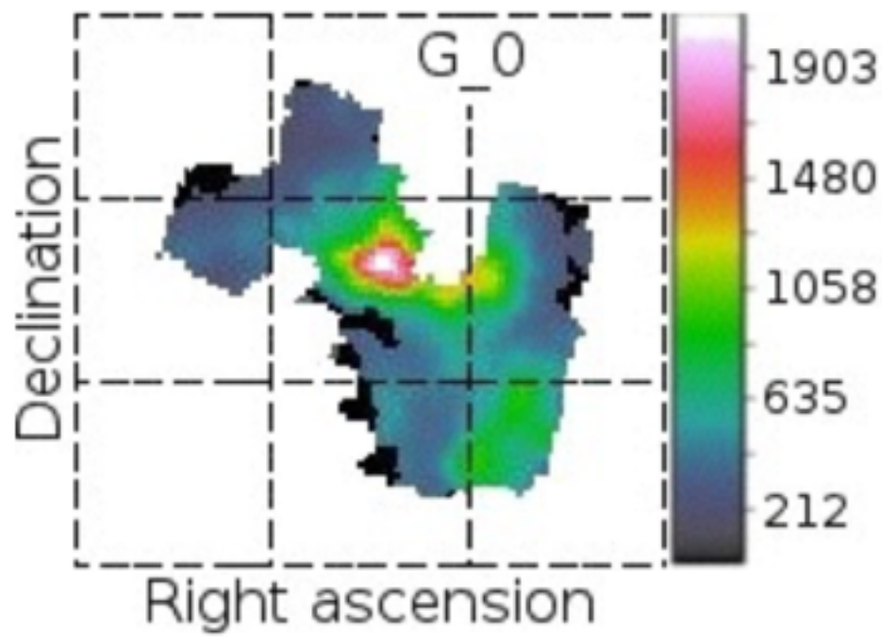


Codes provides

- n(X)
- excitation in quantum levels
- T_{gas}, T_{dust}
- ...

- I(X)
- N(X)
- spectre



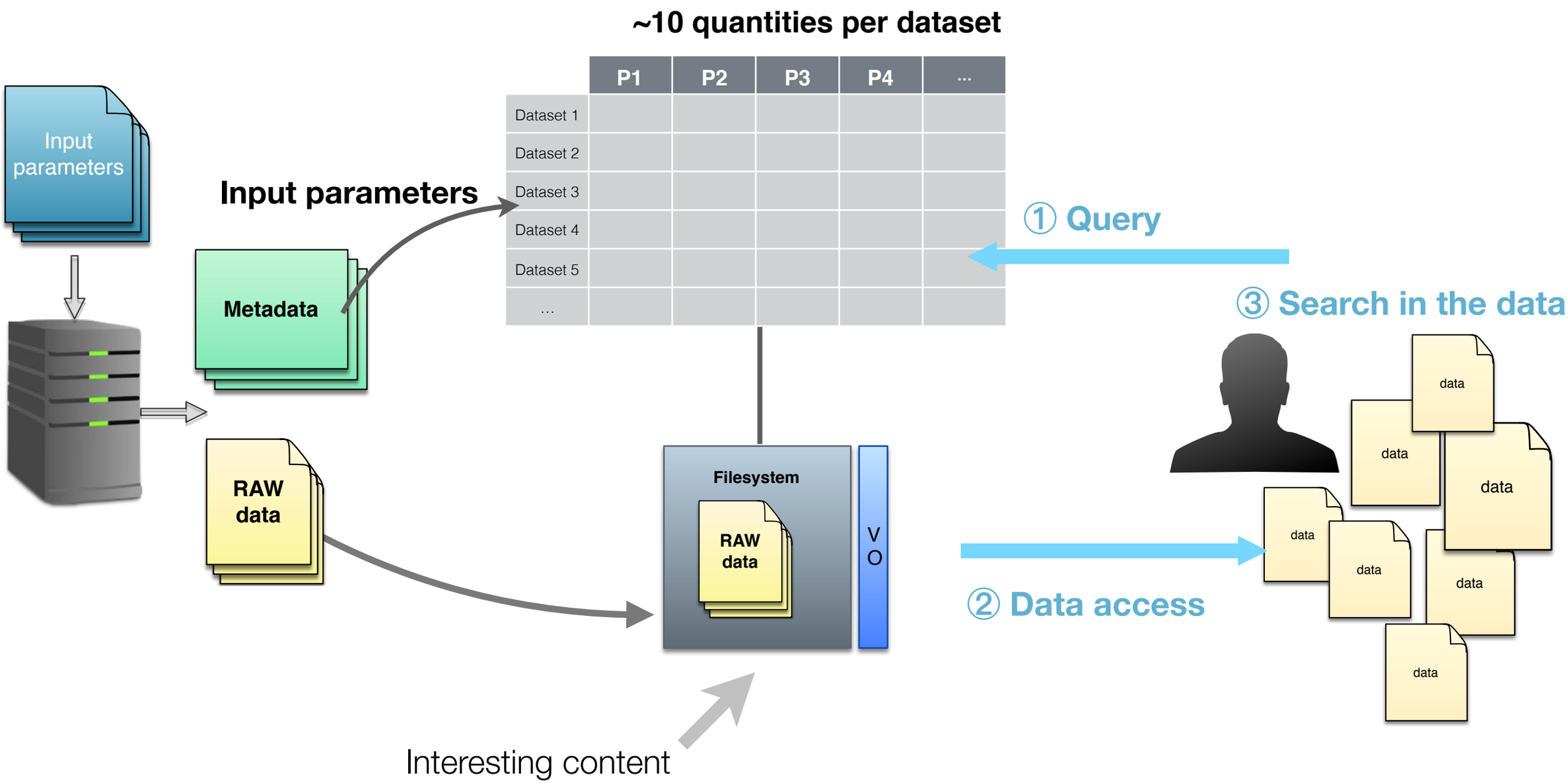


ISMDB

ISMDB: InterStellar Medium DataBase

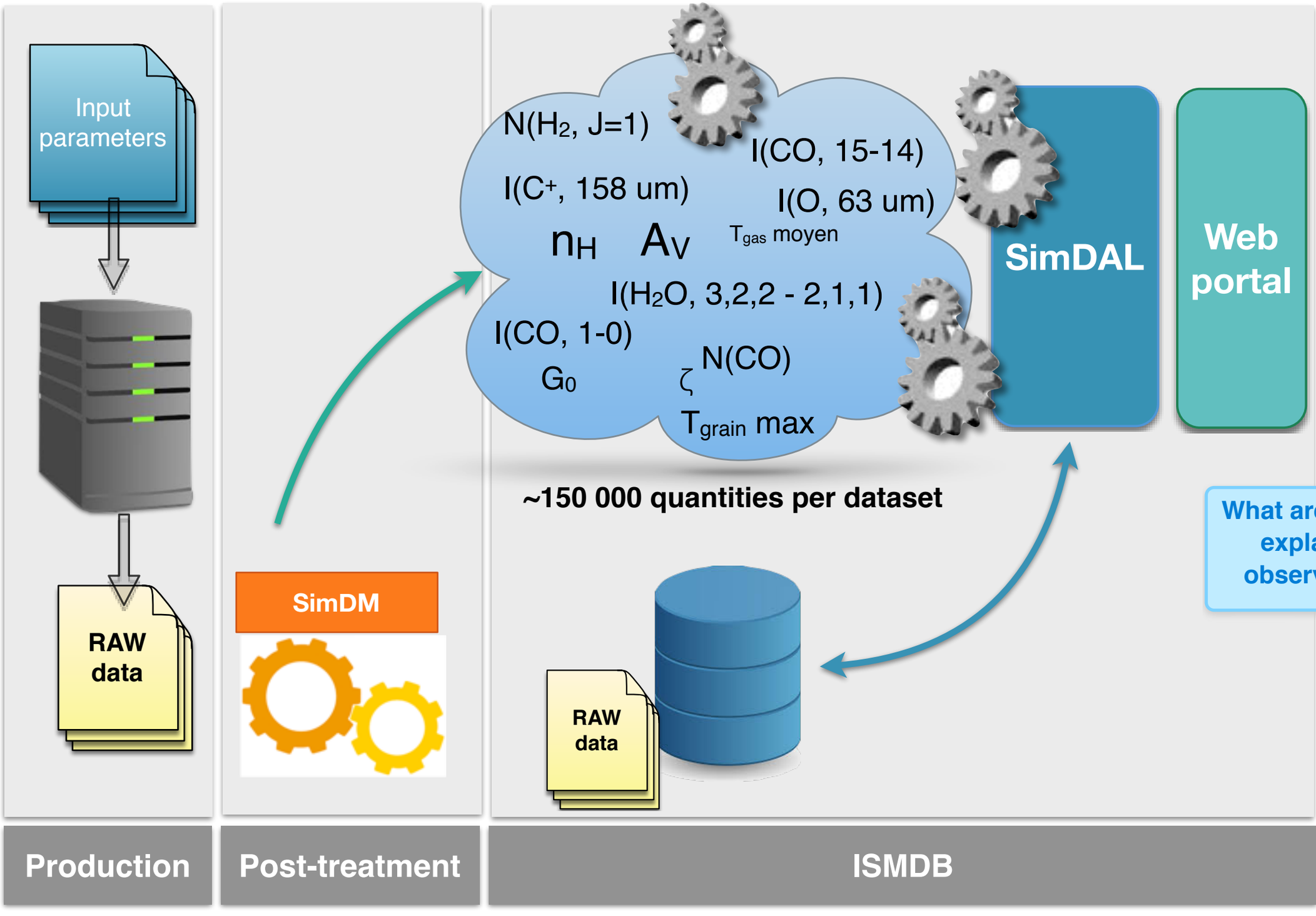
- not only a classical database to find pre-computed models
- but **also a tool that can *interpret* observations**

Standard databases:



ISMDB

- not only a classical database to find pre-computed models
- but **also a tool that can *interpret* observations**



ISMDB

Production of large grids of PDR models
- ~ 3000 PDR models in ISMDB for **standard galactic conditions**
- ~ 10 To of data

Cover: **PDR models for Herschel, IRAM/Noema, JWST, ALMA … observations**

- Each model is caracterized by + 150 000 queriable quantities
  - input parameters
  - computed **line intensities** (H_2, CO, H_2O, …)
  - **column densities** (total and in quantum levels)

- Raw data contains
  - all computed quantities (spatial profiles, …)
  - **spectra**
  - …

ISMDB

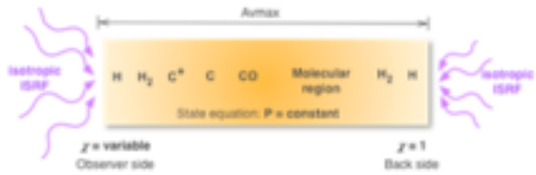
Models are stored in two projects
- isobaric models
- isochoric models

Help Contact

ISM DataBase – Inverse Search service Beta

Grid of isobaric PDR 1.5.2 models *(2016-12-03)*

code: PDR 1.5.2 rev 1714



Parameters

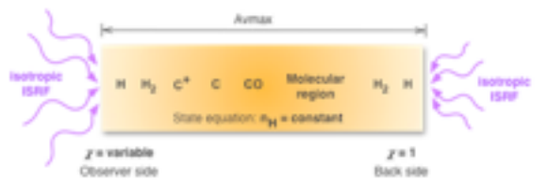
avmax:	from 1.0 to 40.0 (mag)
radm_ini:	from 1.0 to 1E5 (Mathis unit)
gas_pressure_input:	from 1E5 to 1E9 (K cm-3)

Description

This grid of isobaric PDR 1.5.2 models (revision 1714) covers photo-dominated regions conditions. Explored parameters are thermal pressure, UV field intensity and size of the clouds. The full grid contains 1372 2-side models where the back side of the cloud is submitted to the ISRF.
The chemistry takes into account 222 species, including C and O isotopes, linked by 6243 chemical reaction. No surface reactions are considered excepted for H2. H2 formation model takes into account Eley-Rideal and Langmuir-Hinshelwood mechanisms as described in Le Bourlot et al. (2012).
These models give access to all quantities computed by PDR 1.5.2 (line intensities, column densities, densities, temperature of gas and grains, ...).

Grid of isochoric PDR 1.5.2 models *(2017-02-17)*

code: PDR 1.5.2 rev 1787



Parameters

avmax:	from 1.0 to 30.0 (mag)
proton_density_input:	from 1E2 to 1E8 (cm-3)
radm_ini:	from 1.0 to 1E5 (Mathis unit)

Description

This grid of isochoric PDR 1.5.2 models (revision 1787) covers photo-dominated regions conditions. Explored parameters are proton density, UV field intensity and size of the clouds. The full grid contains 2128 2-side models where the back side of the cloud is submitted to the ISRF.
The chemistry takes into account 222 species, including C and O isotopes, linked by 6243 chemical reaction. No surface reactions are considered excepted for H2. H2 formation model takes into account Eley-Rideal and Langmuir-Hinshelwood mechanisms as described in Le Bourlot et al. (2012).
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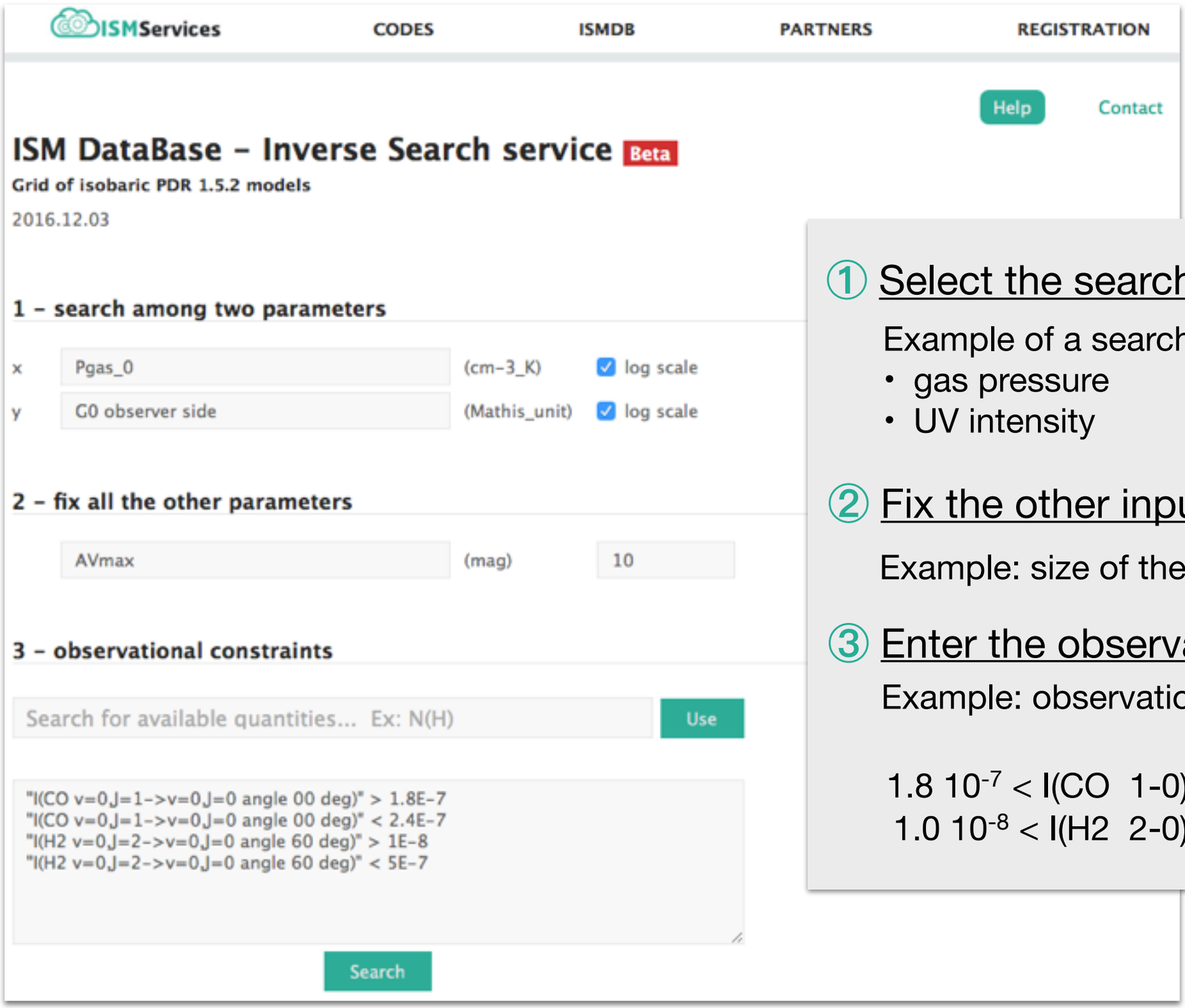
ISMDB



① Select the searched input parameters

Example of a search:

- gas pressure
- UV intensity

② Fix the other input parameters

Example: size of the cloud

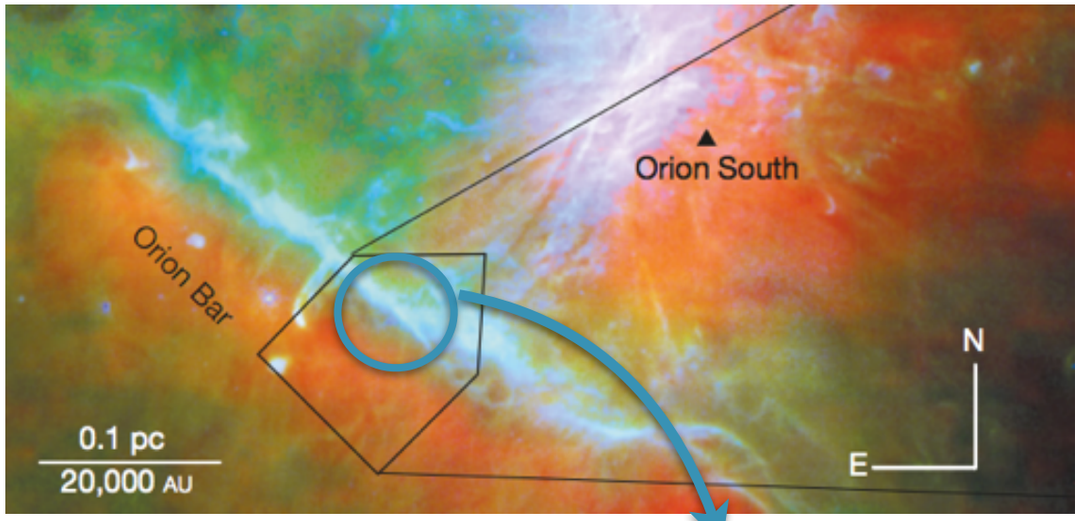
③ Enter the observations

Example: observations CO and H_2 intensities

$1.8\ 10^{-7} < I(CO\ \ 1\text{-}0) < 2.4\ 10^{-7}$ erg cm-2 s-1 sr-1

$1.0\ 10^{-8} < I(H2\ \ 2\text{-}0) < 5.0\ 10^{-7}$ erg cm-2 s-1 sr-1

Interpretation of observations



$1.8\ 10^{-7} < I(CO\ \ 1\text{-}0) < 2.4\ 10^{-7}$ erg cm-2 s-1 sr-1
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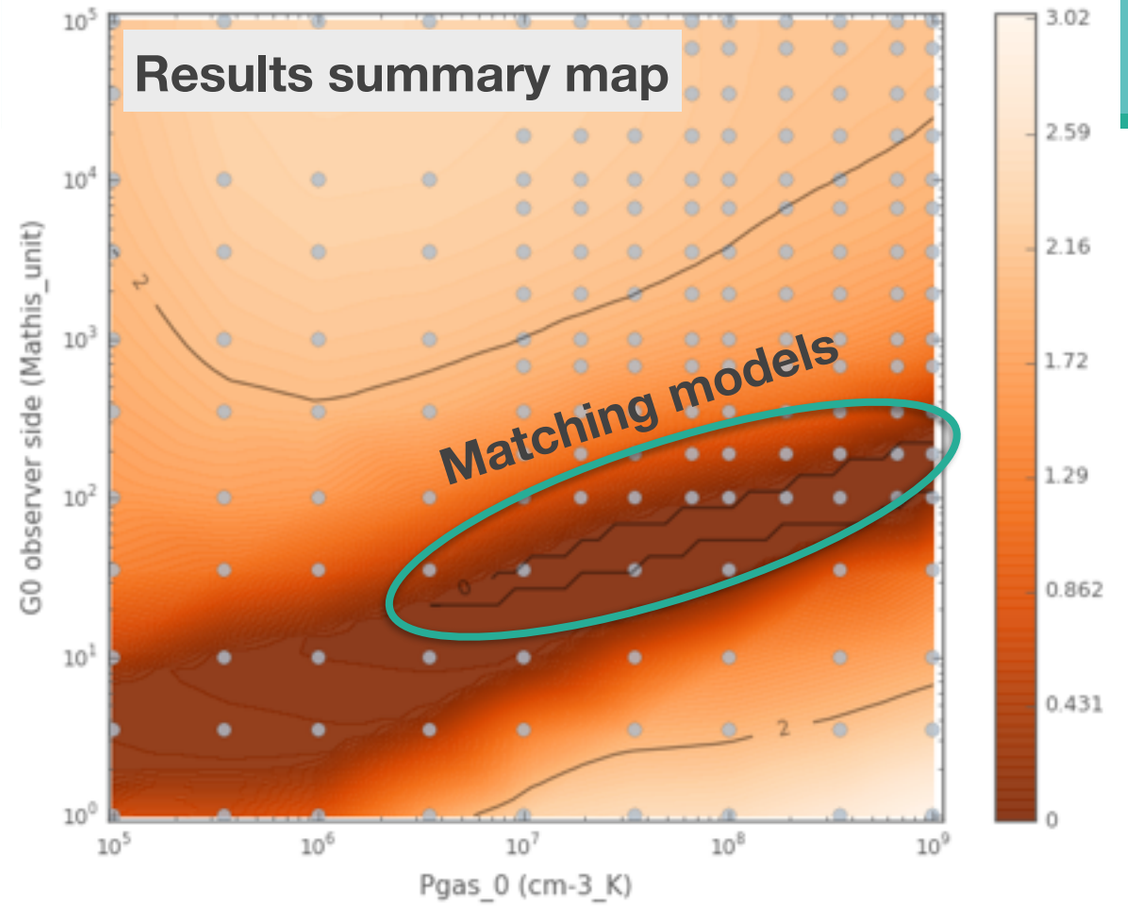
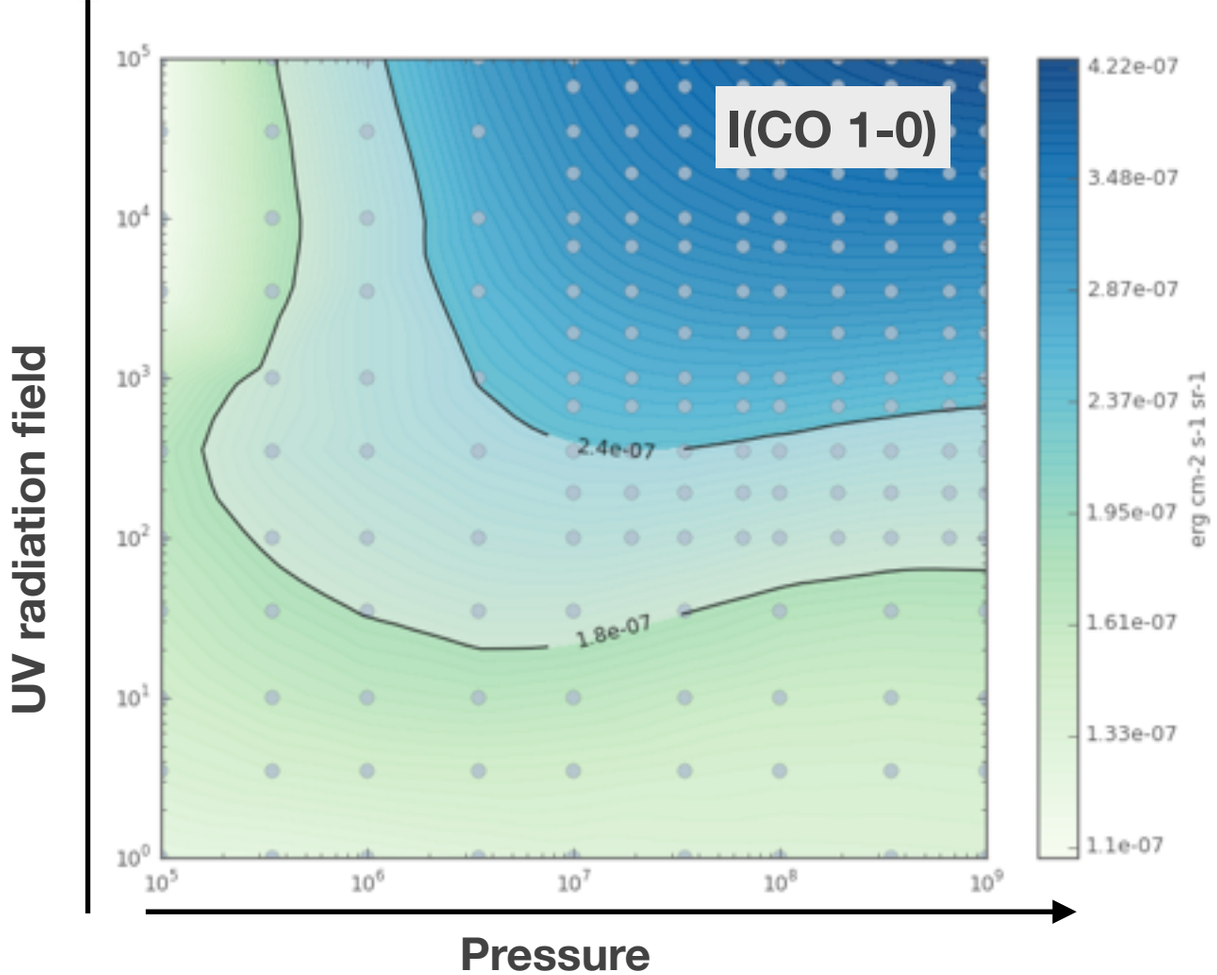
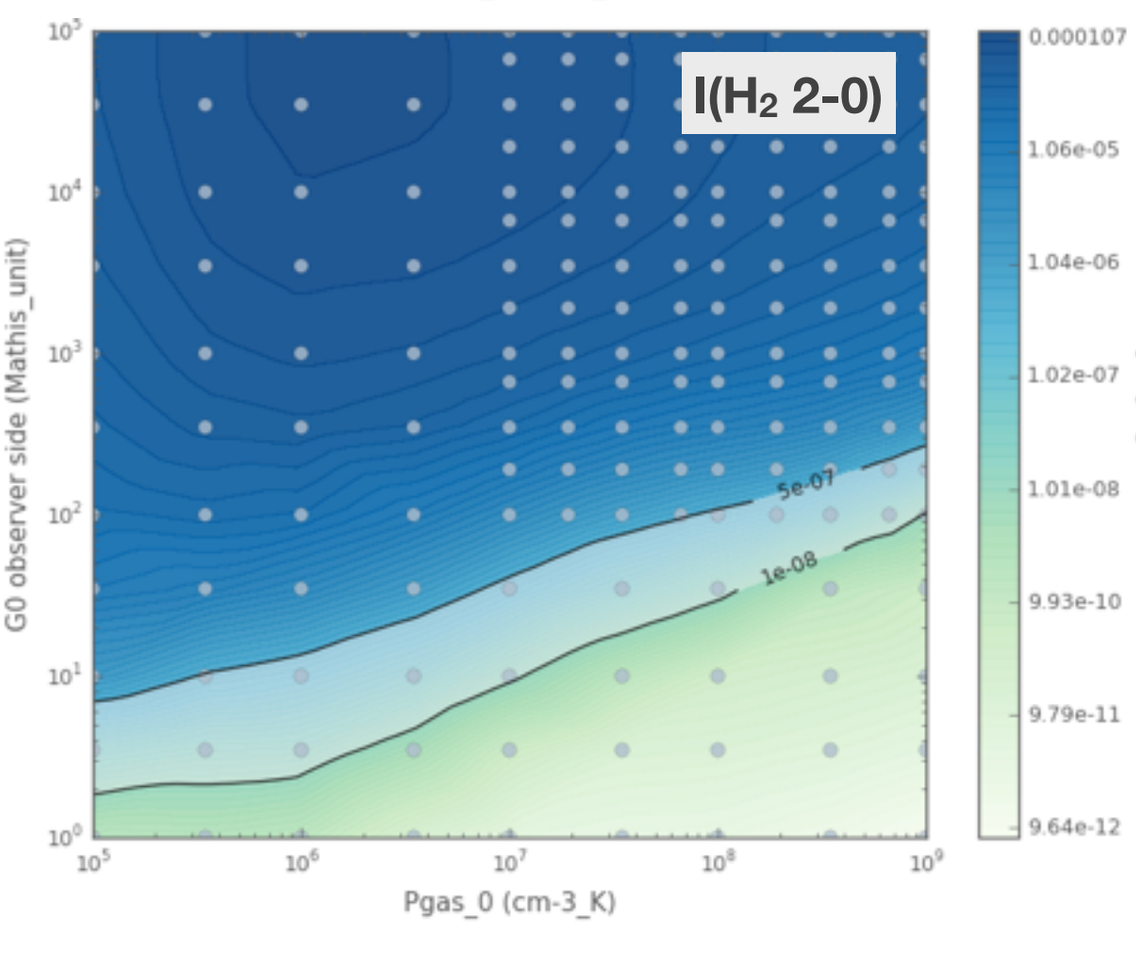
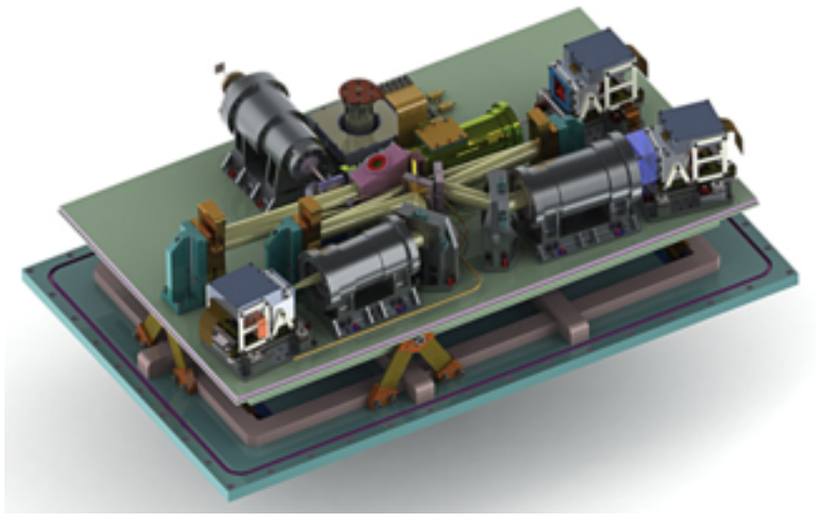






Interpretation of observations

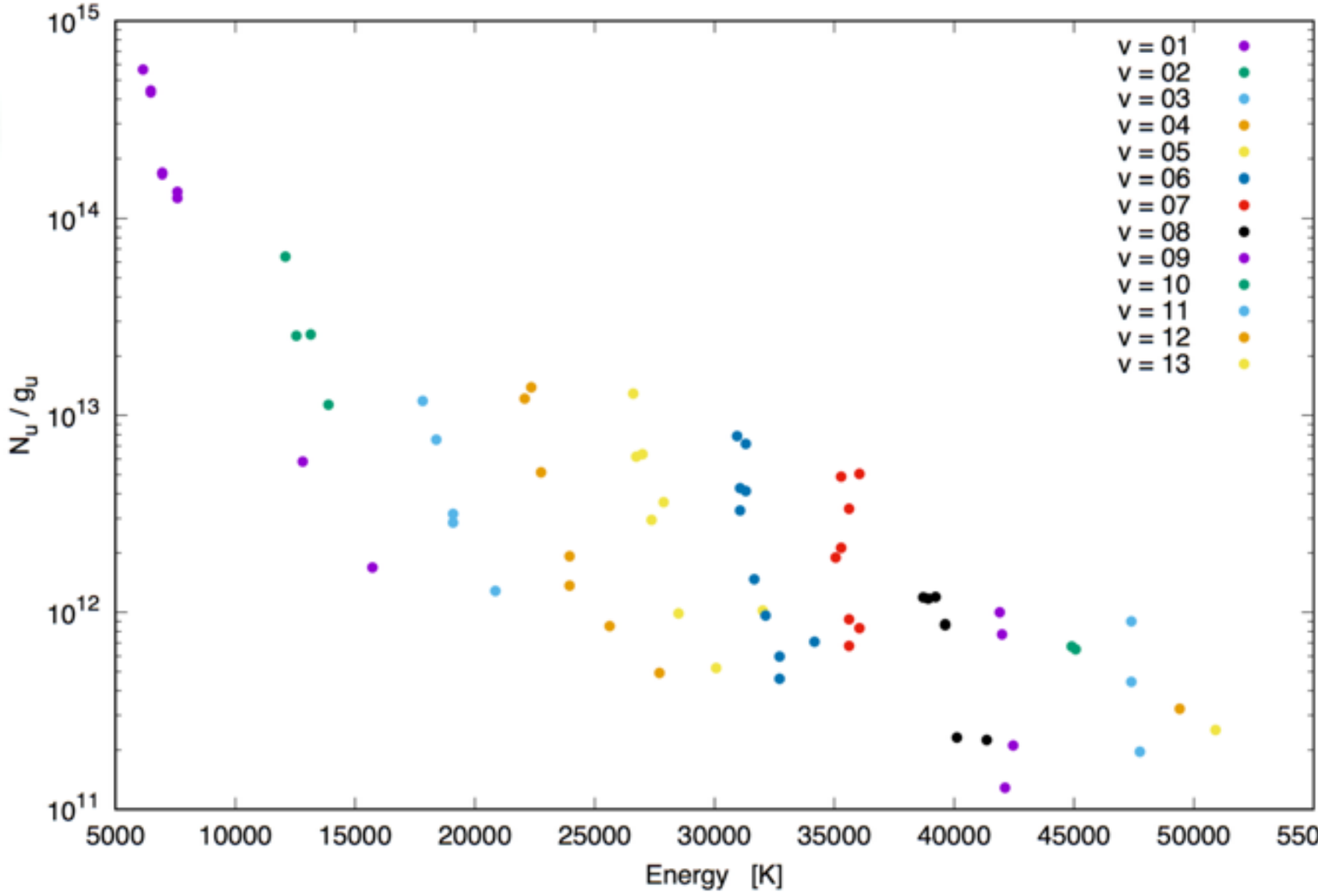
IGRINS observations
Instrument - Univ. Texas, Austin
Mc Donald observatory
Bands: H et K (1.5 to 2.5 microns)
R = 45 000



Observations of NGC 7023
(Le et al. - 2016 / ArXiV)

- Detection of **70 H_2 lines in NGC 7023**
- Conclude to a clumpy medium

H_2 excitation diagram at position A



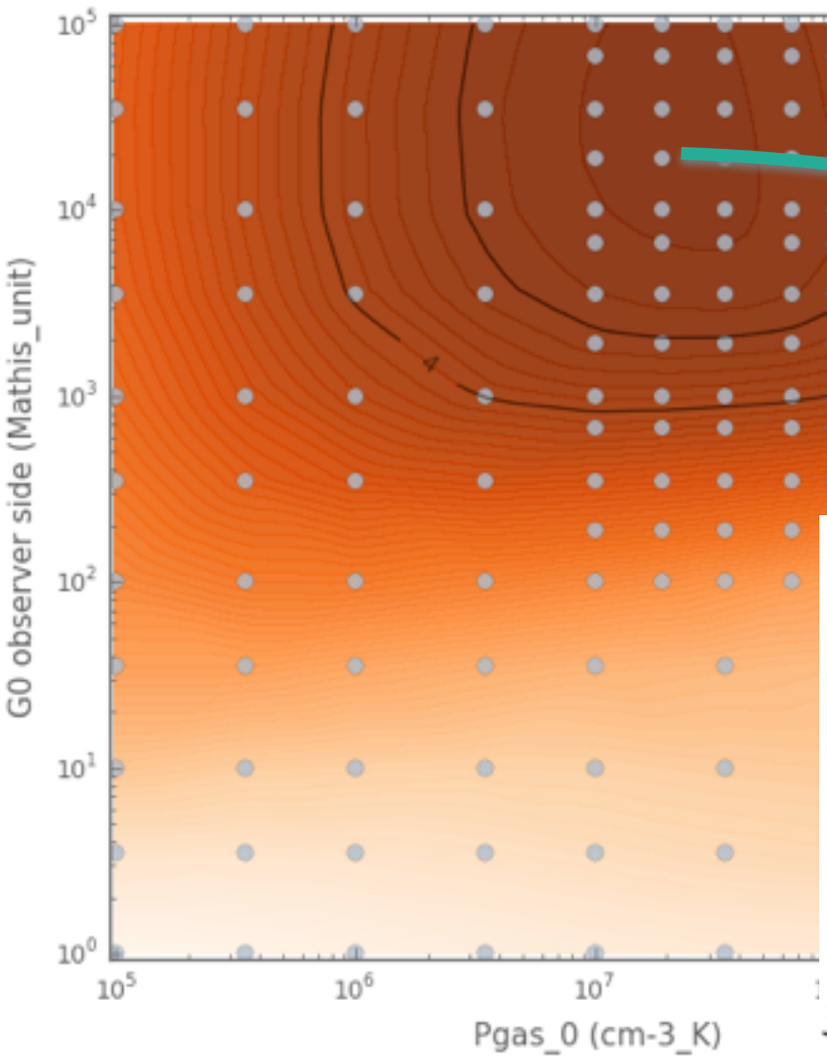
Interpretation of observations

Build the query for the 70 H_2 lines (140 constraints)

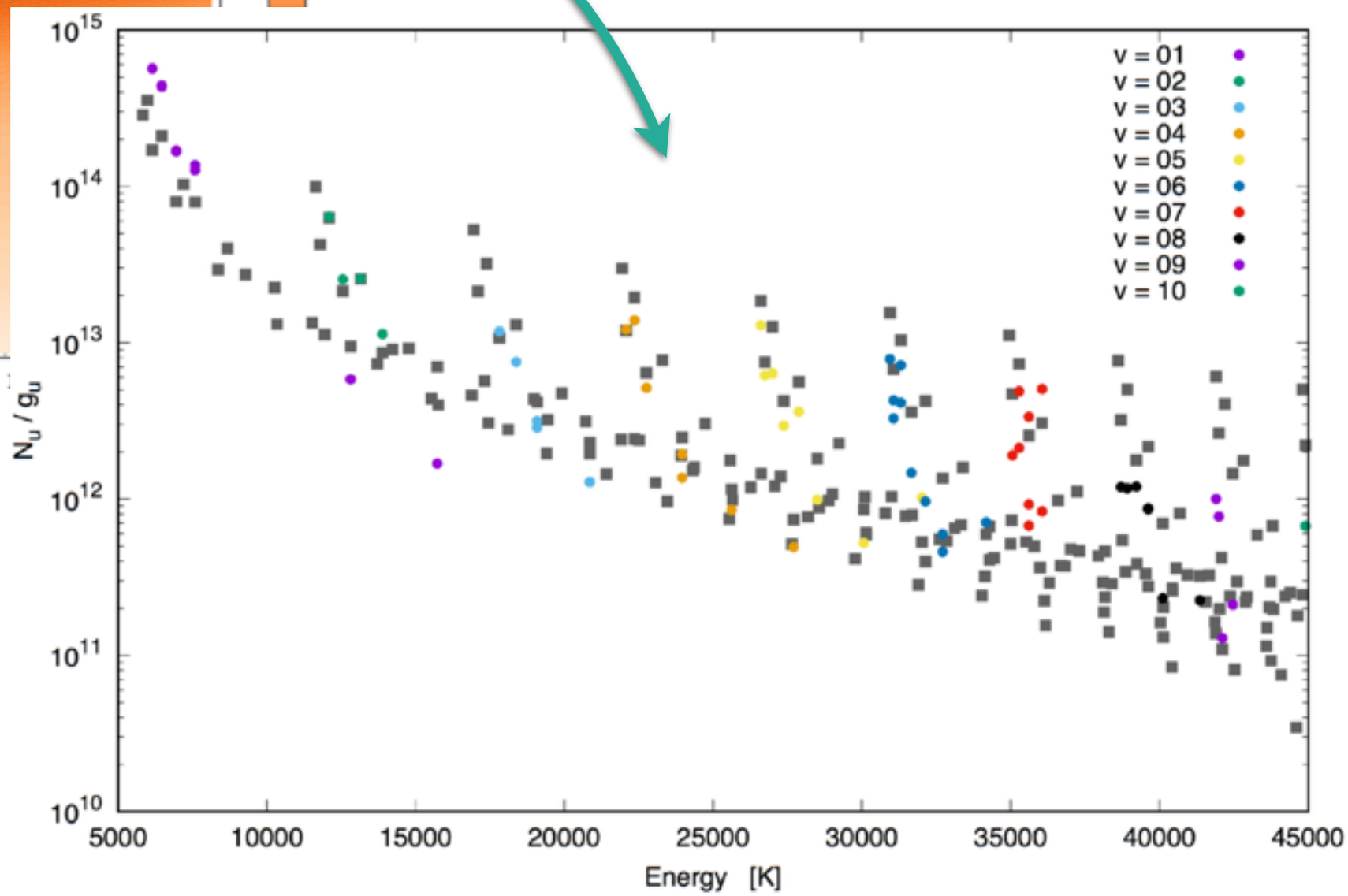
```
"I(H2 v=4,J=9->v=2,J=9 angle 60 deg)" < 5.408e-06
"I(H2 v=4,J=9->v=2,J=9 angle 60 deg)" > 2.912e-06
"I(H2 v=4,J=1->v=2,J=3 angle 60 deg)" < 2.665e-05
"I(H2 v=4,J=1->v=2,J=3 angle 60 deg)" > 1.435e-05
"I(H2 v=5,J=4->v=3,J=4 angle 60 deg)" < 9.659e-06
"I(H2 v=5,J=4->v=3,J=4 angle 60 deg)" > 5.201e-06
"I(H2 v=3,J=3->v=1,J=5 angle 60 deg)" < 1.2532e-05
"I(H2 v=3,J=3->v=1,J=5 angle 60 deg)" > 6.748e-06
"I(H2 v=5,J=5->v=3,J=5 angle 60 deg)" < 9.607e-06
"I(H2 v=5,J=5->v=3,J=5 angle 60 deg)" > 5.173e-06
"I(H2 v=6,J=2->v=4,J=0 angle 60 deg)" < 7.67e-06
"I(H2 v=6,J=2->v=4,J=0 angle 60 deg)" > 4.13e-06
"I(H2 v=10,J=1->v=7,J=3 angle 60 deg)" < 4.121e-06
"I(H2 v=10,J=1->v=7,J=3 angle 60 deg)" > 2.219e-06
"I(H2 v=5,J=0->v=3,J=2 angle 60 deg)" < 1.118e-05
"I(H2 v=5,J=0->v=3,J=2 angle 60 deg)" > 6.02e-06
"I(H2 v=5,J=7->v=3,J=7 angle 60 deg)" < 6.955e-06
"I(H2 v=5,J=7->v=3,J=7 angle 60 deg)" > 3.745e-06
"I(H2 v=4,J=2->v=2,J=4 angle 60 deg)" < 1.1531e-05
"I(H2 v=4,J=2->v=2,J=4 angle 60 deg)" > 6.209e-06
"I(H2 v=7,J=4->v=5,J=2 angle 60 deg)" < 5.109e-06
"I(H2 v=7,J=4->v=5,J=2 angle 60 deg)" > 2.751e-06
"I(H2 v=6,J=1->v=4,J=1 angle 60 deg)" < 1.846e-05
"I(H2 v=6,J=1->v=4,J=1 angle 60 deg)" > 9.94e-06
"I(H2 v=6,J=2->v=4,J=2 angle 60 deg)" < 1.599e-05
"I(H2 v=6,J=2->v=4,J=2 angle 60 deg)" > 8.61e-06
"I(H2 v=5,J=9->v=3,J=9 angle 60 deg)" < 1.729e-05
"I(H2 v=5,J=9->v=3,J=9 angle 60 deg)" > 9.31e-06
"I(H2 v=5,J=1->v=3,J=3 angle 60 deg)" < 2.379e-05
"I(H2 v=5,J=1->v=3,J=3 angle 60 deg)" > 1.281e-05
"I(H2 v=13,J=1->v=9,J=1 angle 60 deg)" < 9.334e-07
"I(H2 v=13,J=1->v=9,J=1 angle 60 deg)" > 5.026e-07
"I(H2 v=6,J=3->v=4,J=3 angle 60 deg)" < 1.287e-05
"I(H2 v=6,J=3->v=4,J=3 angle 60 deg)" > 6.93e-06
```

```
I(H2 v=7,J=3->v=5,J=1 angle 60 deg)" < 1.1531e-05
"I(H2 v=7,J=3->v=5,J=1 angle 60 deg)" > 6.209e-06
"I(H2 v=4,J=3->v=2,J=5 angle 60 deg)" < 1.2961e-05
"I(H2 v=4,J=3->v=2,J=5 angle 60 deg)" > 6.979e-06
"I(H2 v=6,J=4->v=4,J=4 angle 60 deg)" < 3.523e-06
"I(H2 v=6,J=4->v=4,J=4 angle 60 deg)" > 1.897e-06
"I(H2 v=6,J=5->v=4,J=5 angle 60 deg)" < 7.878e-06
"I(H2 v=6,J=5->v=4,J=5 angle 60 deg)" > 4.242e-06
"I(H2 v=3,J=5->v=1,J=7 angle 60 deg)" < 2.457e-06
"I(H2 v=3,J=5->v=1,J=7 angle 60 deg)" > 1.323e-06
"I(H2 v=11,J=1->v=8,J=1 angle 60 deg)" < 2.899e-06
"I(H2 v=11,J=1->v=8,J=1 angle 60 deg)" > 1.561e-06
"I(H2 v=7,J=2->v=5,J=0 angle 60 deg)" < 4.628e-06
"I(H2 v=7,J=2->v=5,J=0 angle 60 deg)" > 2.492e-06
"I(H2 v=8,J=7->v=6,J=5 angle 60 deg)" < 5.824e-06
"I(H2 v=8,J=7->v=6,J=5 angle 60 deg)" > 3.136e-06
"I(H2 v=5,J=2->v=3,J=4 angle 60 deg)" < 9.425e-06
"I(H2 v=5,J=2->v=3,J=4 angle 60 deg)" > 5.075e-06
"I(H2 v=6,J=0->v=4,J=2 angle 60 deg)" < 9.776e-06
"I(H2 v=6,J=0->v=4,J=2 angle 60 deg)" > 5.264e-06
"I(H2 v=6,J=7->v=4,J=7 angle 60 deg)" < 1.2532e-05
"I(H2 v=6,J=7->v=4,J=7 angle 60 deg)" > 6.748e-06
"I(H2 v=11,J=3->v=8,J=3 angle 60 deg)" < 1.924e-06
"I(H2 v=11,J=3->v=8,J=3 angle 60 deg)" > 1.036e-06
"I(H2 v=1,J=11->v=0,J=9 angle 60 deg)" < 4.407e-06
"I(H2 v=1,J=11->v=0,J=9 angle 60 deg)" > 2.373e-06
"I(H2 v=8,J=5->v=6,J=3 angle 60 deg)" < 5.122e-06
"I(H2 v=8,J=5->v=6,J=3 angle 60 deg)" > 2.758e-06
"I(H2 v=7,J=1->v=5,J=1 angle 60 deg)" < 1.2922e-05
"I(H2 v=7,J=1->v=5,J=1 angle 60 deg)" > 6.958e-06
"I(H2 v=8,J=4->v=6,J=2 angle 60 deg)" < 5.109e-06
"I(H2 v=8,J=4->v=6,J=2 angle 60 deg)" > 2.751e-06
"I(H2 v=6,J=1->v=4,J=3 angle 60 deg)" < 2.405e-05
…
…
…
…
```

Interpretation of observations

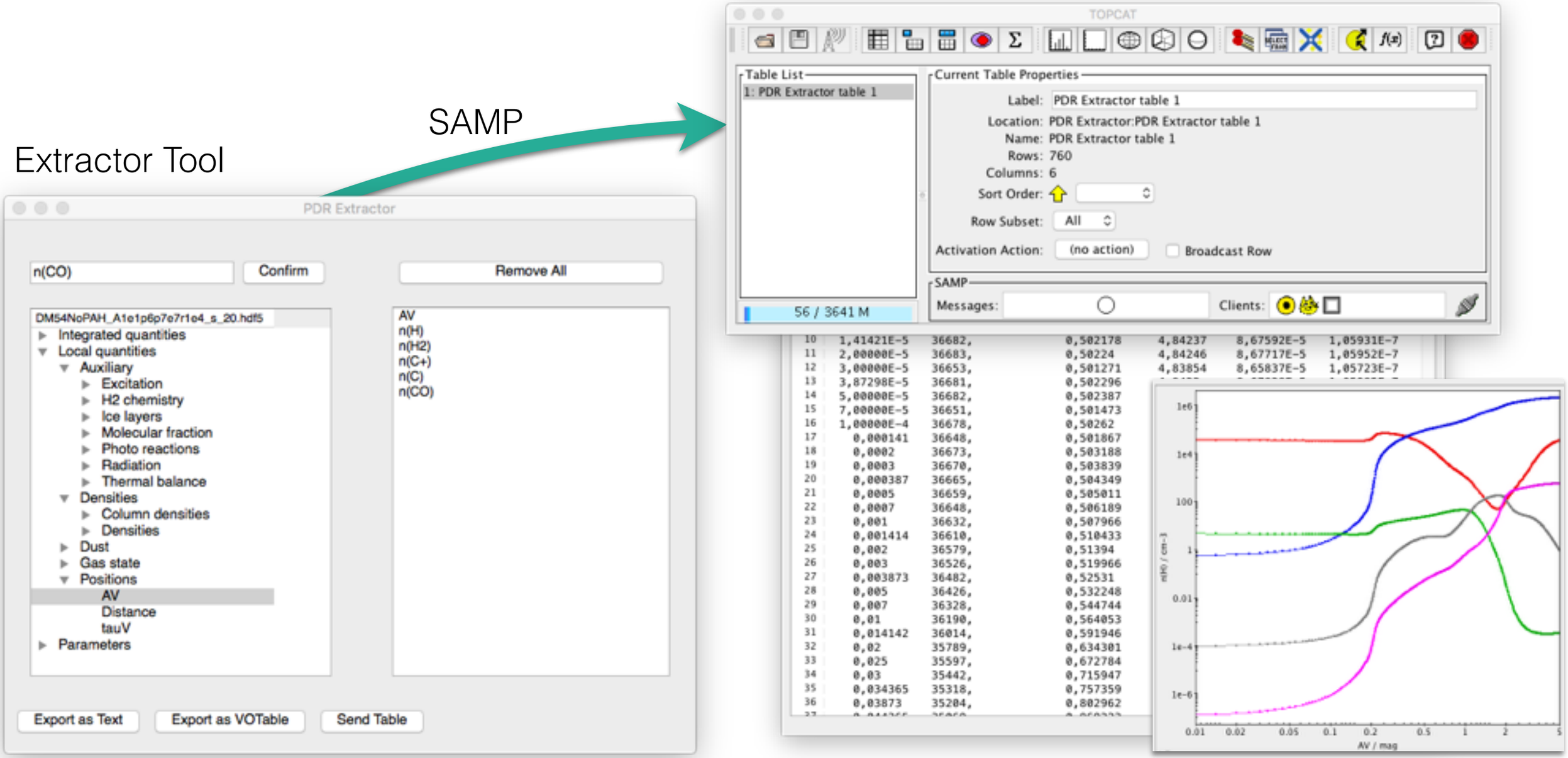


Download models



VO Integration

Metadata definition & organization	**Simulation Data Model (SimDM)**
Data Access	**Simulation Data Access Layer (SimDAL)**
Raw data (extractor tool)	**VOTable** **SAMP connector**



Technical challenges

Large amount of metadata ➔ 2 main difficulties

1 - high dimension database

Standard solution: RDBMS / SQL

	Meta1	Meta2	Meta3	Meta4	…
Dataset 1					
Dataset 2					
Dataset 3					
Dataset 4					
Dataset 5					
…					

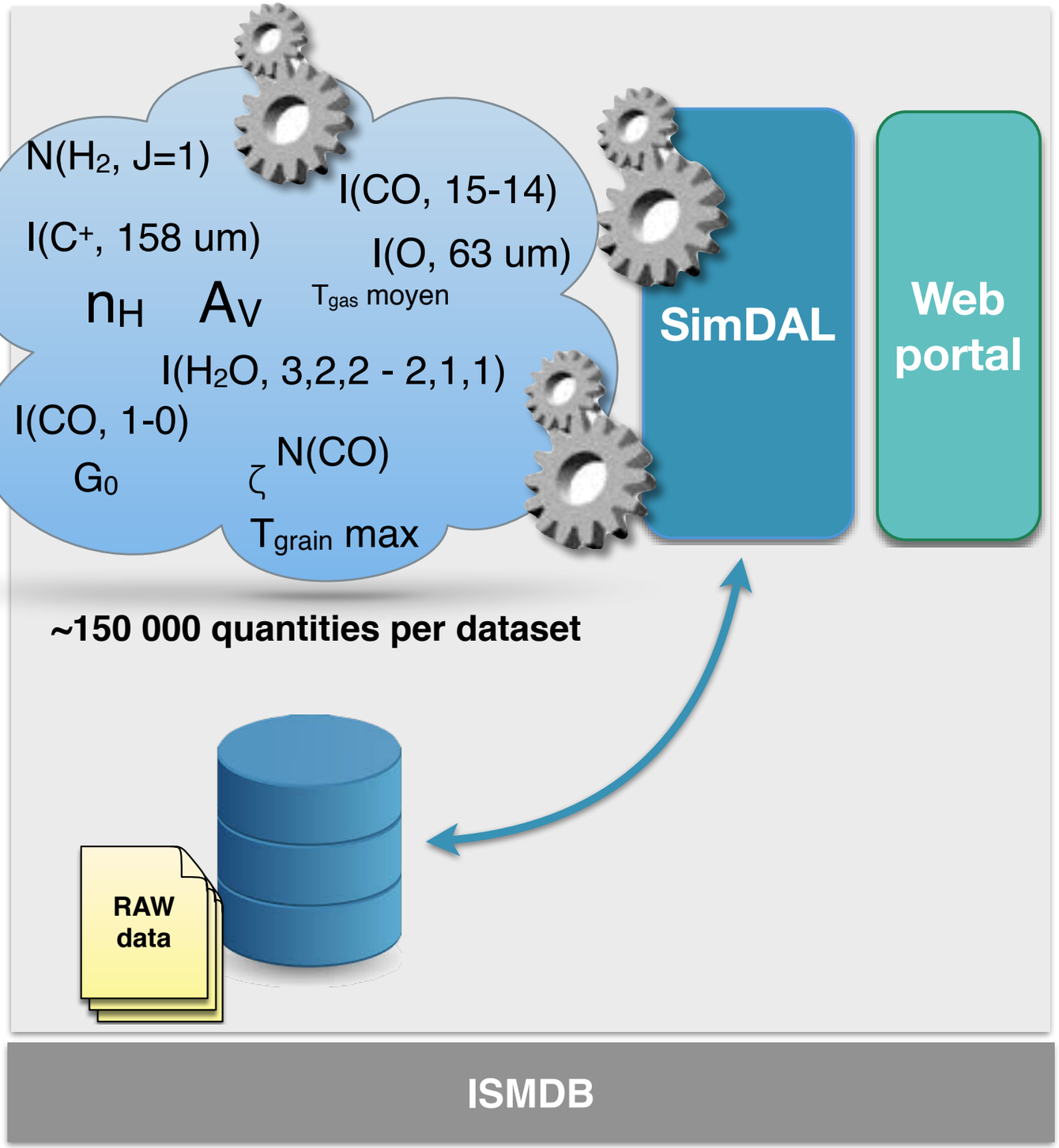
	Number of col.
MySQL	**4096**
Postgress	**250 - 1600**
Oracle	**1000**
Microsoft	**30000**

Standard solutions for databases (RDBMS/SQL) are not adapted to high dimensions / heterogeneous data

ISMDB must manipulate more than 100 000 dimensions

Technical challenges

2 - interaction between a human and the system



What are the models that can explain the I(CO 10-9) I observed with Herschel ?

How the user can know the name of the available quantities ?

Technical challenges

VLA archive Interface

NRAO Science Data Archive : Advanced Search Tool

Historical VLA, Jansky VLA, VLBA and GBT Data Products

Submit Query | Check Query | Clear Form

Output Control Parameters :

Choose Query Return Type :
- Download Archive Data Files
- VLA Observations Summary
- List of Observation Scans
- List of Projects

Output Tbl Format: HTML
Max Output Tbl Rows: NO LIMIT
Sort Order Column 1: Starttime Asc
Sort Order Column 2: Starttime Asc

General Search Parameters :

Telescopes: All | Jansky VLA | Historical VLA | VLBA | GBT

Project Code (GBT: AGBT12A_055, JVLA: 12A-256)
Project Session
Dates From
To (2010-06-21 14:20:30)
Observer Name
Archive File ID (partial strings allowed)

Position Search :

Target Name
Search Type: SIMBAD or NED
Min. Exposure (secs)
RA or Longitude (04h33m11.1s or 68.29d)
DEC or Latitude (05d21'15.5" or 5.352d)
Equinox: J2000
Search Radius: 1.0' (1d00'00" or 0.2d)
- OR - Check for automatic VLA field-of-view, freq. dependent.??

Observing Configurations Search :

Telescope Config: All | A | AB | BnA | B | BC | CnB | C | CD | DnC | D | DA
Sub_array: All | 1 | 2 | 3 | 4 | 5
Polarization: ALL
Data Type: ALL

Observing Bands: All | 4 | P | L | S | C | X | U | K | Ka | Q | W
Frequency Range (In MHz : 1665.401 - 1720.500)

Enter Locked Project Access key :

Unique keywords may be used to unlock proprietary data from individual observing projects. Contact the NRAO Data Analysts for project access keys.

Submit Query | Check Query | Clear Form

23 paramètres de recherche
Interface complexe

Technical challenges

VLA archive Interface

NRAO Science Data Archive : Advanced Search Tool

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Min. Exposure (secs)
RA or Longitude (04h33m11.1s or 68.29d)
DEC or Latitude (05d21'15.5" or 5.352d)
Equinox: J2000
Search Radius: 1.0' (1d00'00" or 0.2d)
- OR - Check for automatic VLA field-of-view, freq. dependent.??

Observing Configurations Search :

Telescope Config: All | A | AB | BnA | B | BC | CnB | C | CD | DnC | D | DA
Sub_array: All | 1 | 2 | 3 | 4 | 5
Polarization: ALL
Data Type: ALL
Observing Bands: All | 4 | P | L | S | C | X | U | K | Ka | Q | W
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Submit Query | Check Query | Clear Form

23 paramètres de recherche
Interface complexe

ISMDB
150 000 parameters !

Brian Glendenning, NRAO, InterOp Heidelberg 2013

Semantics

ISMServices CODES ISMDB

ISM DataBase – Inverse Search service Beta

Grid of isobaric PDR 1.5.2 models

2016.12.03

1 – search among two parameters

x Pgas_0 (cm-3_K) log scale

y G0 observer side (Mathis_unit) log scale

2 – fix all the other parameters

AVmax (mag) 10

3 – observational constraints

Search for available quantities... Ex: N(H) Use

"I(CO v=0,J=1->v=0,J=0 angle 00 deg)" > 1.8E-7
"I(CO v=0,J=1->v=0,J=0 angle 00 deg)" < 2.4E-7
"I(H2 v=0,J=2->v=0,J=0 angle 60 deg)" > 1E-8
"I(H2 v=0,J=2->v=0,J=0 angle 60 deg)" < 5E-7

Search

3 – observational constraints

Search for available quantities... Ex: N(H) Use

Semantics interpreter

Semantics

Each metadata is taggued by:

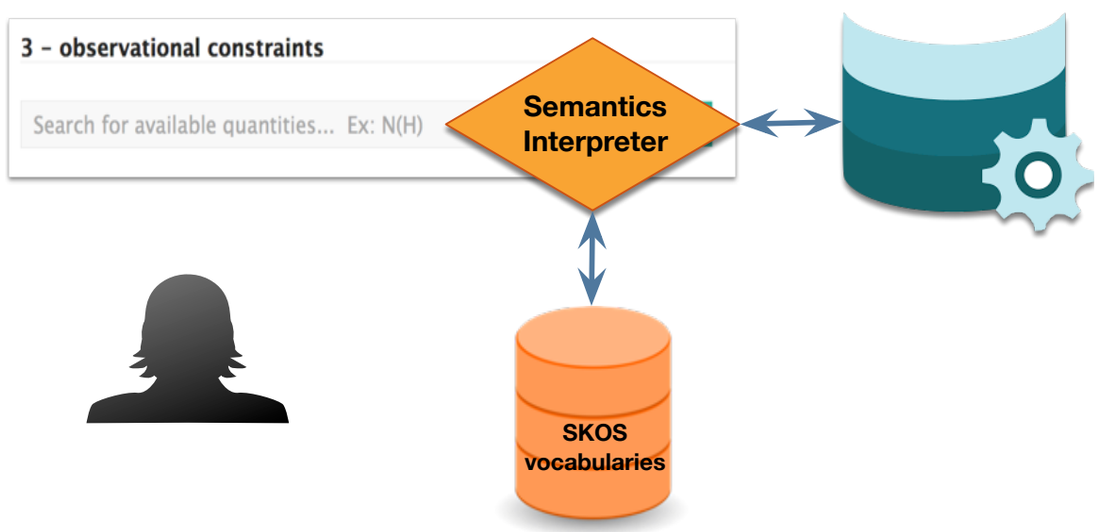
- ID
- name
- unit
- utype
- description
- **label (UCD / SKOS)**
- …

Simulation DataModel

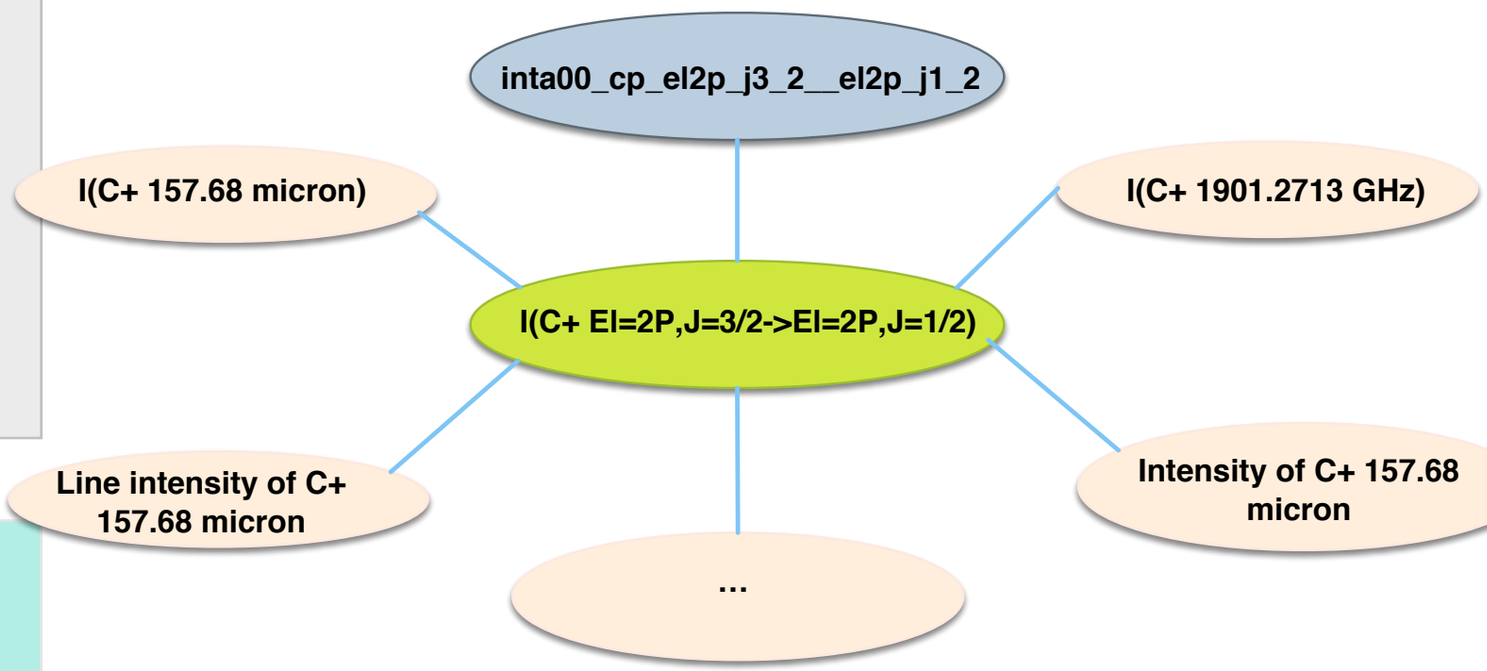
SKOS vocabulary

For each quantity several synonyms (name, units, …)

~ 300 000 terms for the PDR code

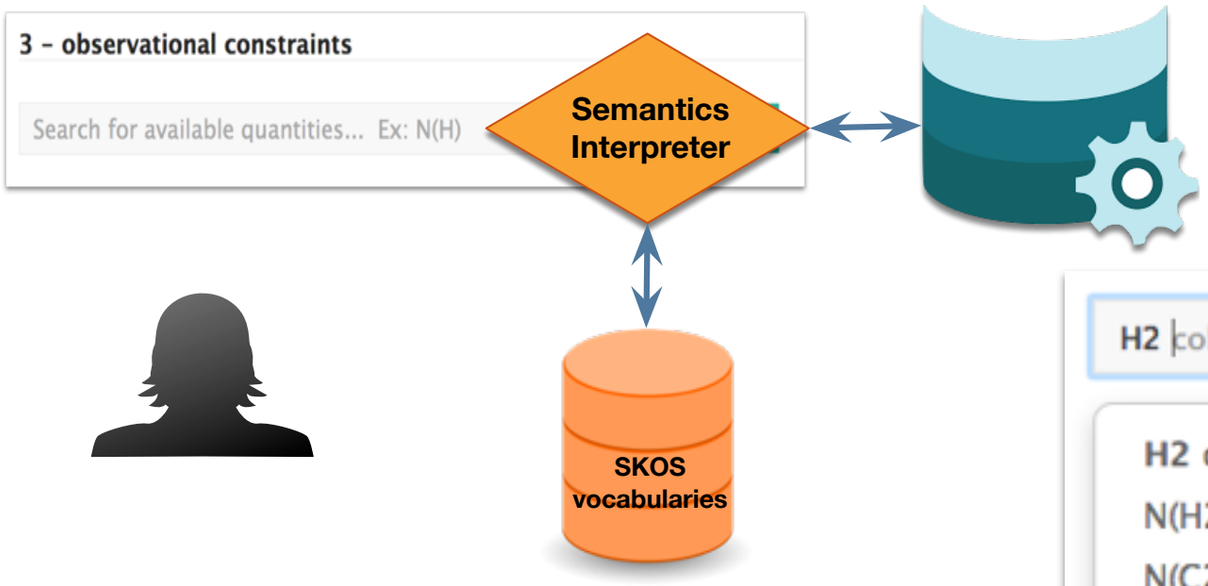


Example of the 157.7 micron C+ line intensity



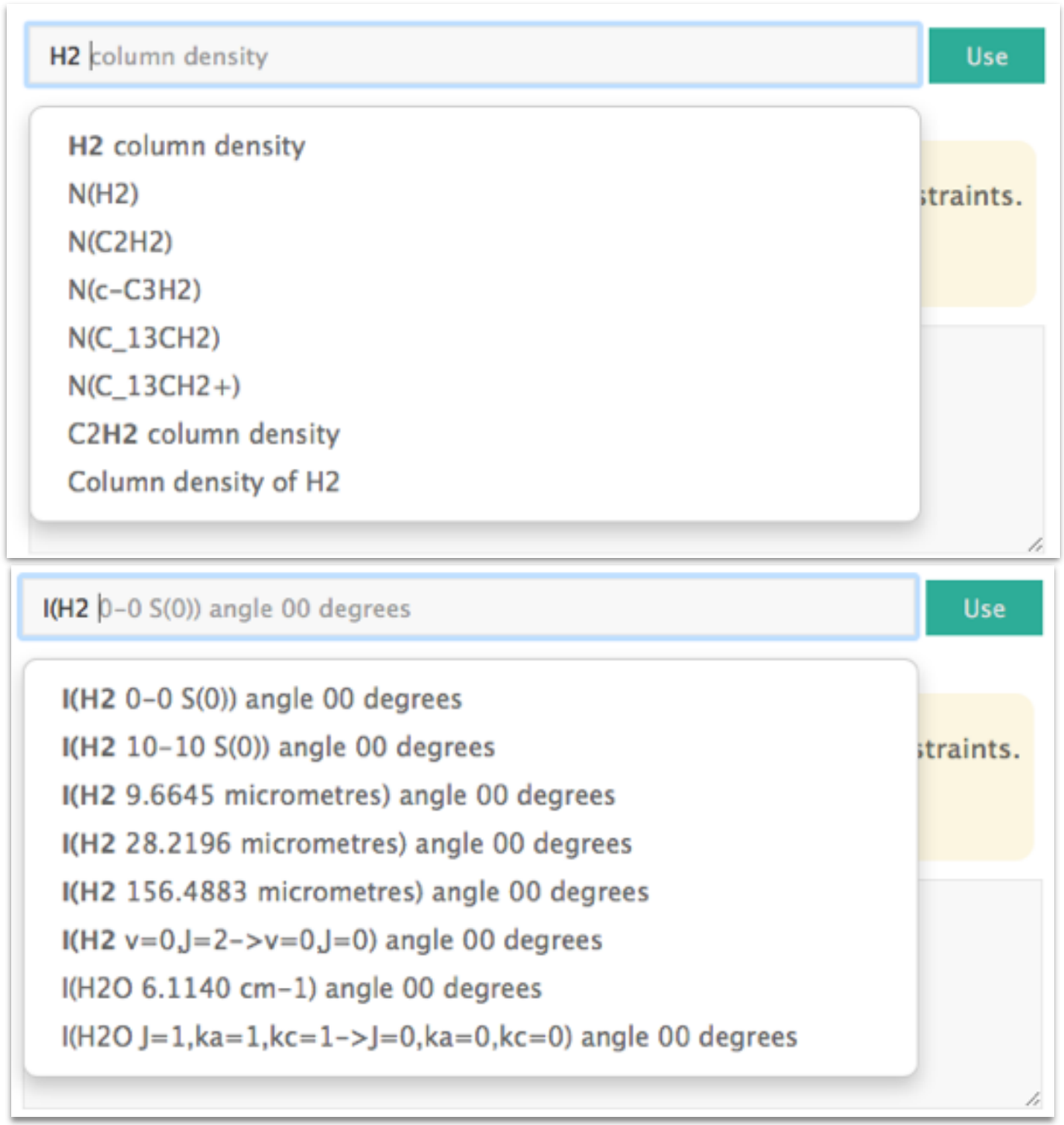
ID: inta00_cp_el2p_j3_2__el2p_j1_2
PREF: I(C+ El=2P,J=3/2->El=2P,J=1/2)
ALT: I(C+ El=2P,J=3/2->El=2P,J=1/2) face on
ALT: I(C+ 157.68 micron) face on
ALT: Intensity of C+ 157.68 micron face on
ALT: Line intensity of C+ 157.68 micron face on
ALT: I(C+ 1901.2713 GHz) face on
ALT: Intensity of C+ 1901.2713 GHz face on
ALT: Line intensity of C+ 1901.2713 GHz face on
…

Technical challenges



Semantics Interpreter

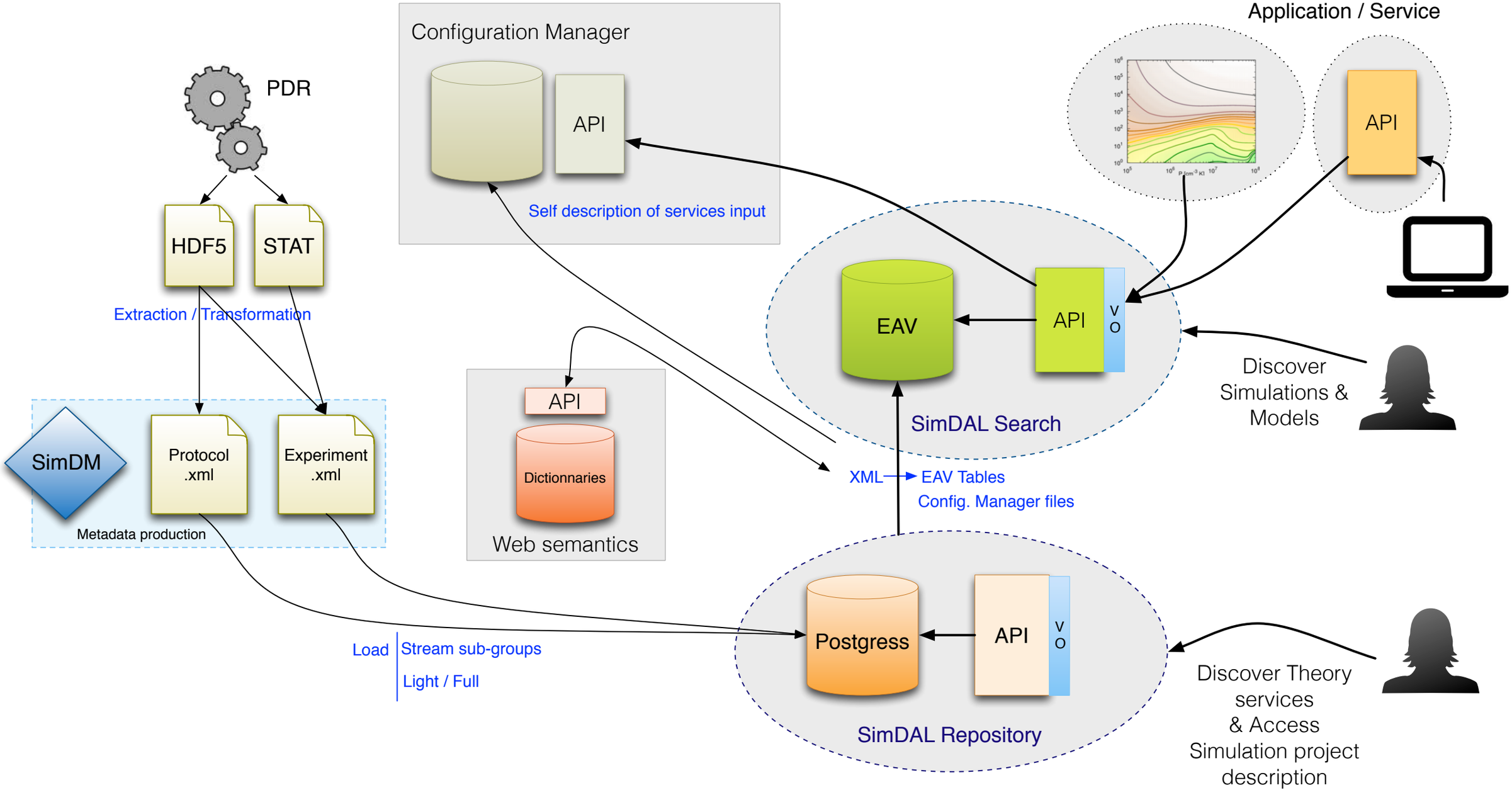
Semantics
SKOS: PREF + ALT
➔ synonyms
+
Ranking system
(learn from users)



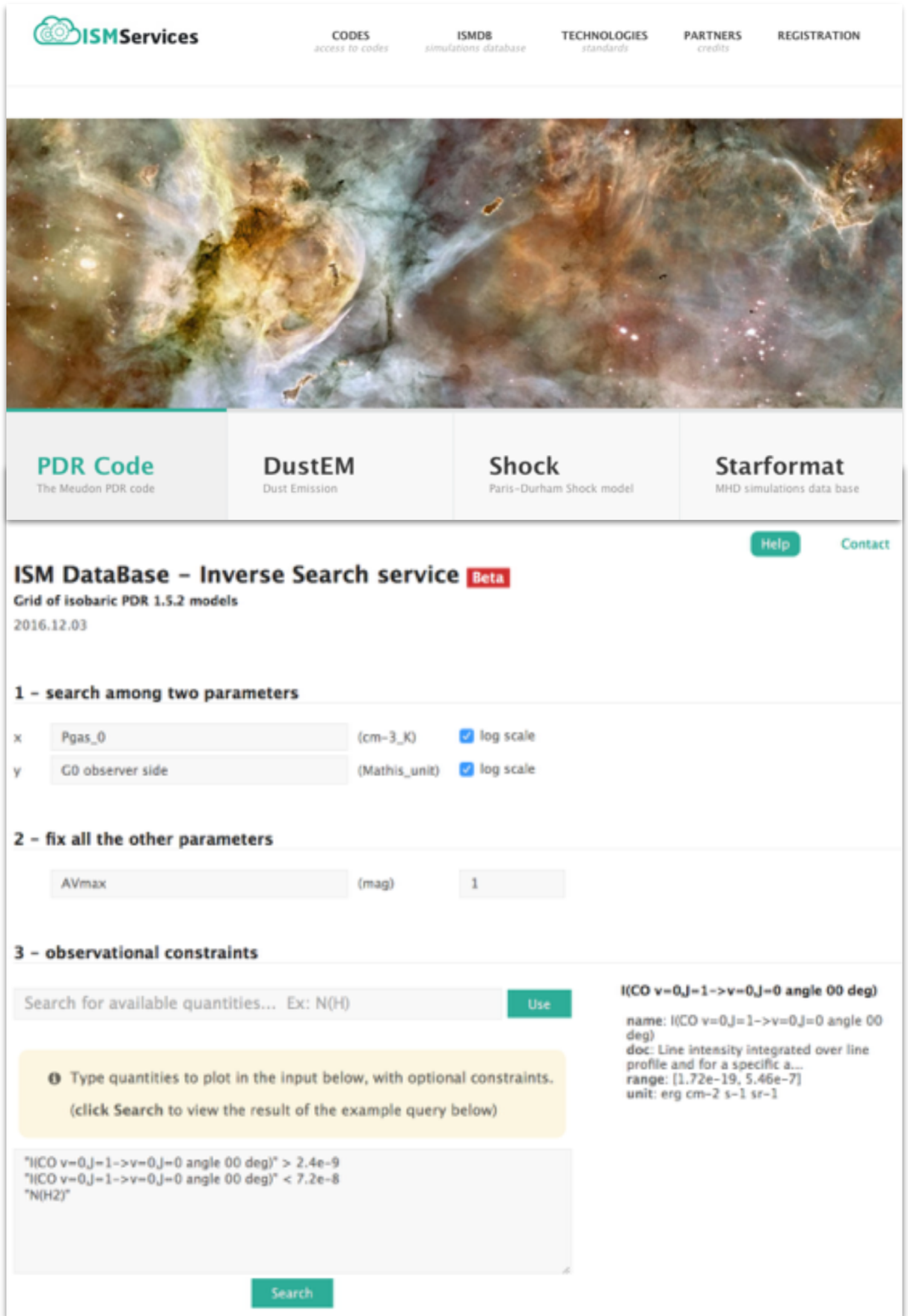
ISMDB infrastructure

ISMDB infrastructure development

- **modular**
- based on **robust & mature technologies**
- **generic**: can integrate models from any similar code than the PDR code



ISMDB



Status

- Public at **http://ism.obspm.fr**
- Grids of PDR models

Starts to be used:

- Individual teams
- Projects as SPICA, GUSTO (NASA/CNES)
- JWST ERS

Plans - short term

- Semantics
- Grids of shocks models
- Operations on quantities

Plans - medium term

- Other ways to query models
- Quickviews on models

Plans - long term

- Search in N-dimension space
- Interpretation at each pixels of maps

VO-Theory

Status on standards

Franck Le Petit
David Languignon
Nicolas Moreau
Zakaria Meliani

VO-Theory standards

SimDM

- approved a few years ago
- no evolution

SimDAL

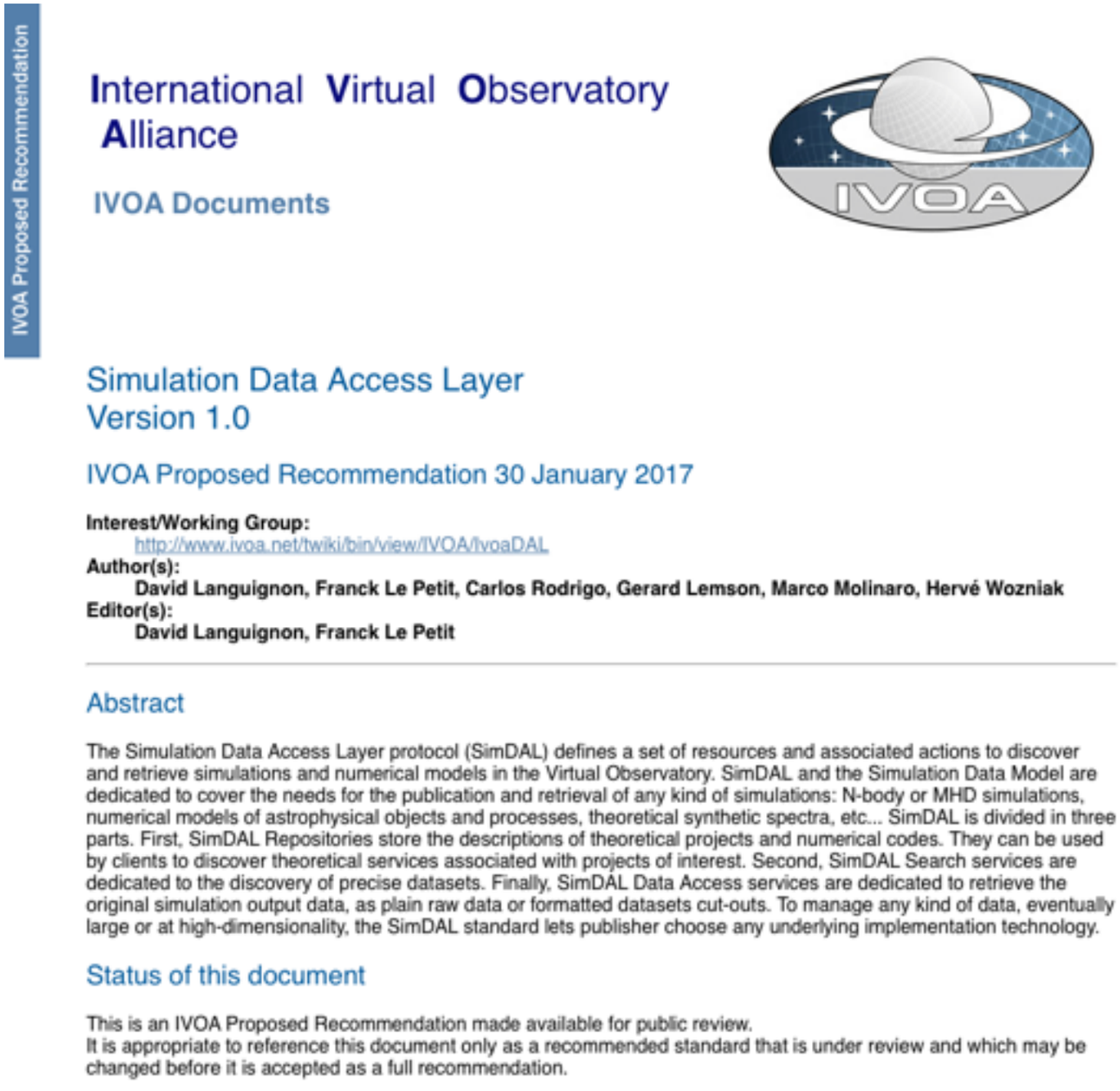
Access to theoretical data
(consider big / heterogeneous data)

- 2 reference implementations + client
- all WG / IG have done their comments
- few modifications (clarifications of the text)

➔ start of implementions on other services

Everything ready for the integration of theoretical data in the Virtual Observatory

Both documents on the IVOA documents page



IVOA Proposed Recommendation

International Virtual Observatory Alliance

IVOA Documents

IVOA

Simulation Data Access Layer
Version 1.0

IVOA Proposed Recommendation 30 January 2017

Interest/Working Group:
http://www.ivoa.net/twiki/bin/view/IVOA/IvoaDAL
Author(s):
David Languignon, Franck Le Petit, Carlos Rodrigo, Gerard Lemson, Marco Molinaro, Hervé Wozniak
Editor(s):
David Languignon, Franck Le Petit

Abstract

The Simulation Data Access Layer protocol (SimDAL) defines a set of resources and associated actions to discover and retrieve simulations and numerical models in the Virtual Observatory. SimDAL and the Simulation Data Model are dedicated to cover the needs for the publication and retrieval of any kind of simulations: N-body or MHD simulations, numerical models of astrophysical objects and processes, theoretical synthetic spectra, etc... SimDAL is divided in three parts. First, SimDAL Repositories store the descriptions of theoretical projects and numerical codes. They can be used by clients to discover theoretical services associated with projects of interest. Second, SimDAL Search services are dedicated to the discovery of precise datasets. Finally, SimDAL Data Access services are dedicated to retrieve the original simulation output data, as plain raw data or formatted datasets cut-outs. To manage any kind of data, eventually large or at high-dimensionality, the SimDAL standard lets publisher choose any underlying implementation technology.

Status of this document

This is an IVOA Proposed Recommendation made available for public review.
It is appropriate to reference this document only as a recommended standard that is under review and which may be changed before it is accepted as a full recommendation.

VO-Theory standards

Remise à plat du service d'accès aux vocabulaires pour SimDM / SimDAL

Nicolas Moreau
Zakaria Meliani
David Languignon
Franck Le Petit

Vocabularies:

- Algorithms
- Astronomical objects
- Data object types
- Physical processes
- Physical quantities

To be used to tag quantities in SimDM

Will be discussed at next InterOp