



Sémantique

dans l'OV et pour la Théorie

Franck Le Petit, Nicolas Moreau
Zakaria Méliani , David Languignon, Emeric Bron



Sémantique dans l'Observatoire Virtuel

Besoin de donner un **sens** aux données échangées

- Facilite compréhension des données par un humain
- Permet à une machine de reconnaître des quantités
- Facilite le matching de quantités entre différents services

Très tôt dans la construction de l'Observatoire Virtuel:

- **UCD**: United Content Descriptors

et un peu plus tard:

- **Ontologie** des objets astronomiques
- **Vocabulaires VO-Theory** (utilisés par le Simulation Data Model)

Depuis 2-3 ans, les travaux s'intensifient autour de la sémantique

- Besoin d'élargissement des UCD
- Plusieurs DataModel utilisent les notions de vocabulaires

UCD

UCD Vocabulaire contrôlé

Exemples: *em.wl, pos.eq.ra*

Usages des UCD s'élargissent

Ex: *Euro Planet, EPN-TAP, etc ...*

InterOp de mai 2018

- **UCD+1**

<http://www.ivoa.net/documents/UCD1+>

- **Maintenance des listes d'UCD**

<http://www.ivoa.net/documents/UCDlistMaintenance/20180823/>

→ Révision de la liste des UCD

→ Précision des règles pour construire UCD

→ Définition de la procédure pour modifier et maintenir la liste des UCD

UCD scientific board sous la responsabilité du chair du président du groupe sémantique

Service de recherche d'UCD au CDS:

<http://cds.u-strasbg.fr/UCD/cgi-bin/descr2ucd>

International Virtual Observatory Alliance



IVOA Documents

The UCD1+ controlled vocabulary Version 1.3 Version 1.3

IVOA Recommendation 27 May 2018

Interest/Working Group:

<http://www.ivoa.net/twiki/bin/view/IVOA/IvoaSemantics>

Author(s):

Andrea Preite Martinez, Mireille Louys, Baptiste Cecconi, Sebastien Derriere, François Ochsenbein, and the IVOA Semantic Working group

Editor(s):

Andrea Preite Martinez, Mireille Louys

Abstract

This document describes the list of controlled terms used to build the Unified Content Descriptors, Version 1+ (UCD1+). The document describing the UCD1+ can be found at the URL: <http://www.ivoa.net/Documents/latest/UCD.html>. This document reviews the structure of the UCD1+ and presents the current vocabulary. This version contains new UCD words for the planetary data community as proposed in the Technical Note by Cecconi et al. [3]. The suggested list of line labels under the em.line branch is not included. A general solution is currently under study to deal with lists of element instances such spectral lines, chemical elements, elementary particles, etc. using either utypes or a vocabulary.

Status of this document

This document has been produced by the Semantics Working Group. It has been reviewed by IVOA Members and other interested parties, and has been endorsed by the IVOA Executive Committee as an IVOA Recommendation. It is a stable document and may be used as reference material or cited as a normative reference from another document. IVOA's role in making the Recommendation is to draw attention to the specification and to promote its widespread deployment. This enhances the functionality and interoperability inside the Astronomical Community.

Use this interface to find the UCD corresponding to a description:

Enter a description in natural language:

Clear Form

Reset Form

temperature

Build UCD

Last updated Thu Jun 21 10:24:00 2018

Suggested complete UCD: **phys.temperature**

Refine your search:

The following words matched your query. You might force the selection of words matching precisely your query, and rebuild a UCD using these words:

Clear Form

Reset Form

word	definition	flag	score
<input type="checkbox"/> phys.temperature	Temperature	Q	25
<input type="checkbox"/> phys.temperature.effective	Effective temperature	Q	25
<input type="checkbox"/> phys.temperature.electron	Electron temperature	Q	25
<input type="checkbox"/> phot.antennaTemp	Antenna temperature	E	15
<input type="checkbox"/> spect.line.intensity	Line intensity	E	15

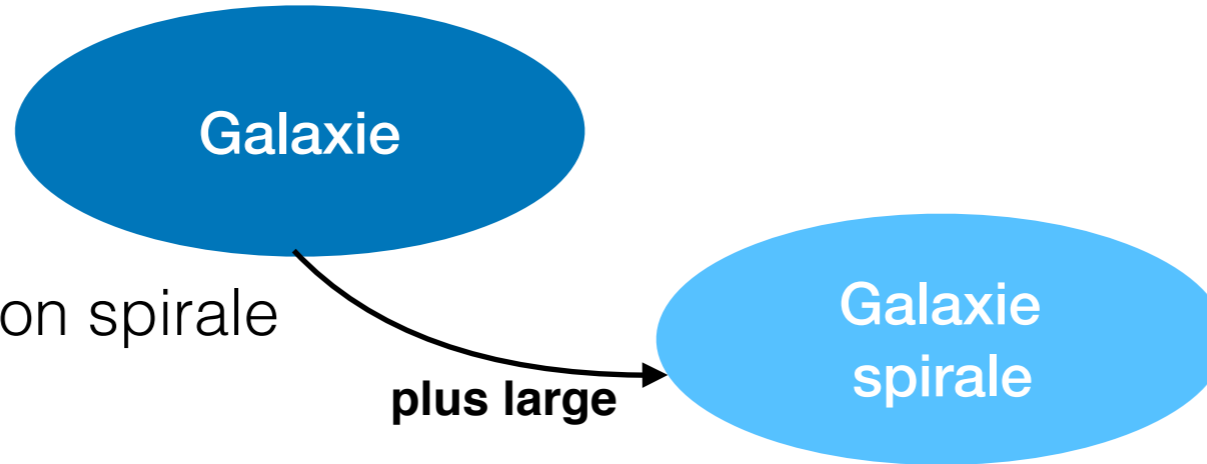
Rebuild UCD using selected words.

Vocabulaires & ontologies

Pour aller plus loin: besoin de **relations entre les concepts**

Exemples:

Galaxie & L'élaboration spirale



Application typique:

- Recherches de services ou de catégories de données

Vocabulaire

- Ensemble de concepts
- Relations entre ces concepts

Exemple vocabulaire VO-Theory

The screenshot shows the PoolParty web interface. On the left, a tree view displays the 'Astronomical algorithms vocabulary' with a list of algorithms such as '3+1 Formalism (0)', 'Accelerated Lambda Iteration (0)', and 'Stationary Iterative Method (3)'. The 'Stationary Iterative Method' is selected. On the right, the 'Visual Browser' displays a network graph with nodes for 'Algorithm', 'Stationary Iterative Method', 'Gauss-Seidel', 'Iterative Method', 'Jacobi Method', and 'Krylov Subspace Method'. The 'Stationary Iterative Method' node is highlighted, and a tooltip shows its SKOS properties: 'skos:prefLabel: Stationary Iterative Method', 'skos:altLabel: Krylov Subspace Method', and 'skos:hiddenLabel: edit'.

Vocabulaires & ontologies

L'élaboration de vocabulaires et les relations entre concepts **dépendent de leurs usages**

Exemple:



Voiture

plus large



Clio



Voiture

plus large



Roue

Les relations des vocabulaires “websemantic” sont orientées pour répondre à des cas d'utilisation

Vocabulaires & ontologies

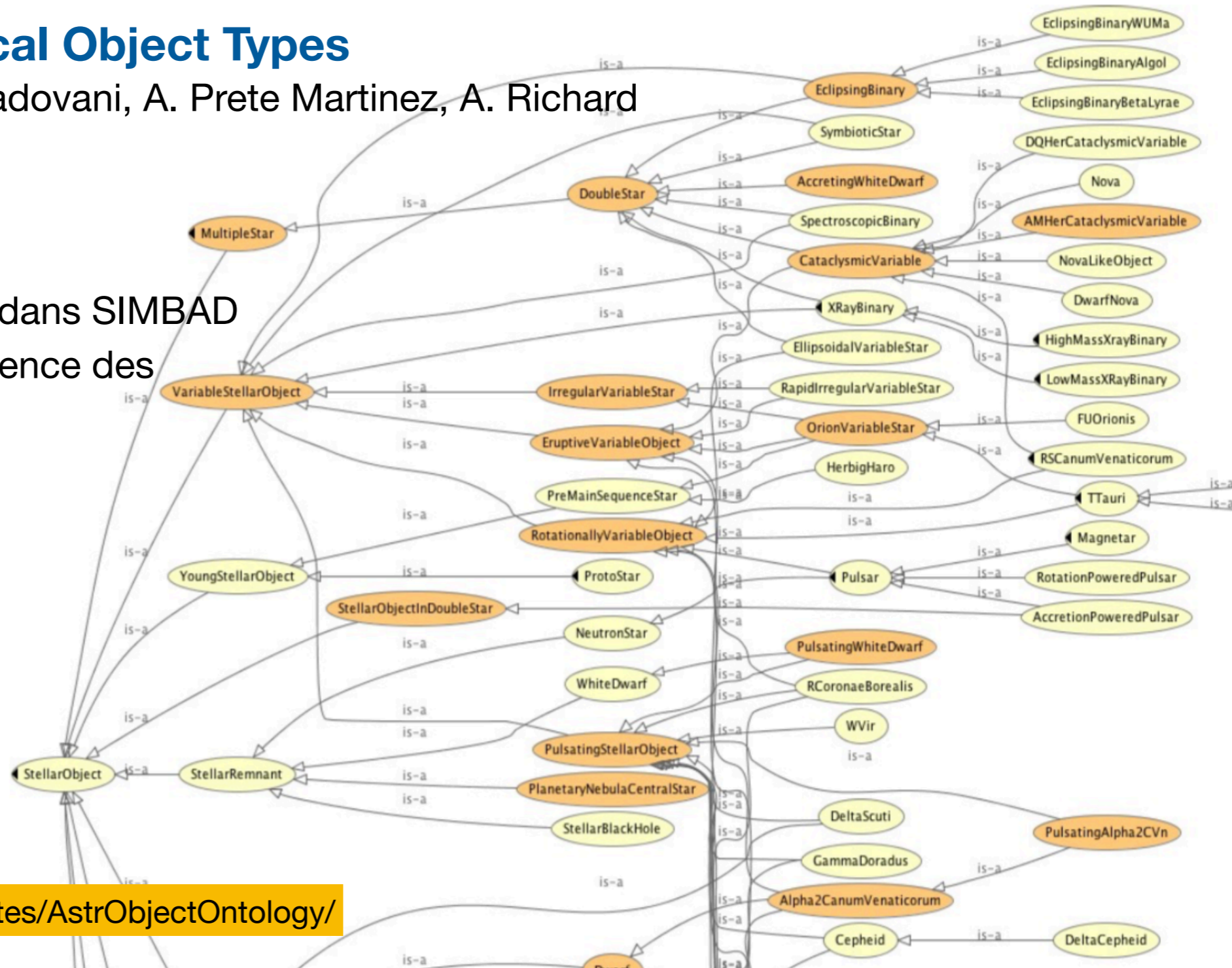
Ontologie (OWL) :

- structure pour représenter et formaliser des connaissances
- définition de relations fines entre concepts

Ontology of Astronomical Object Types

S. Derrière, L. Cambrésy, P. Padovani, A. Prete Martinez, A. Richard

- Basé sur les objets SIMBAD
- Utilisé pour des vérifications dans SIMBAD
- Utilisable pour garantir cohérence des échanges de connaissances:
 - homme - machine
 - machine - machine



Vocabulaires & ontologies

SKOS (Simple Knowledge Organization System)

- Recommandation du WG Semantic de l'IVOA
- Utilisé dans SimDM pour étiqueter des quantités

Relations prédéfinies:

- Pref label
- Alt label
- Broader
- Narrower

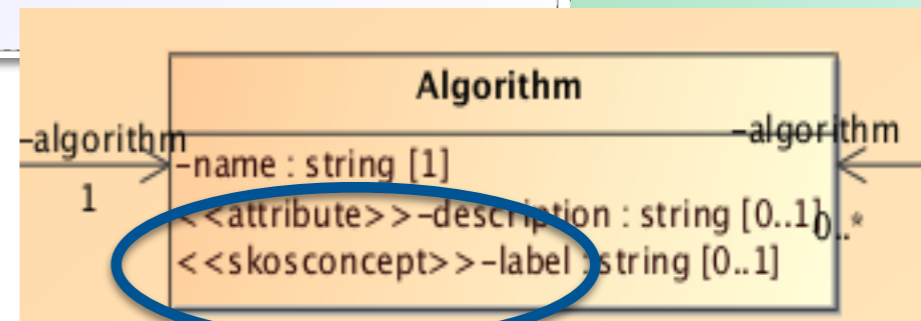
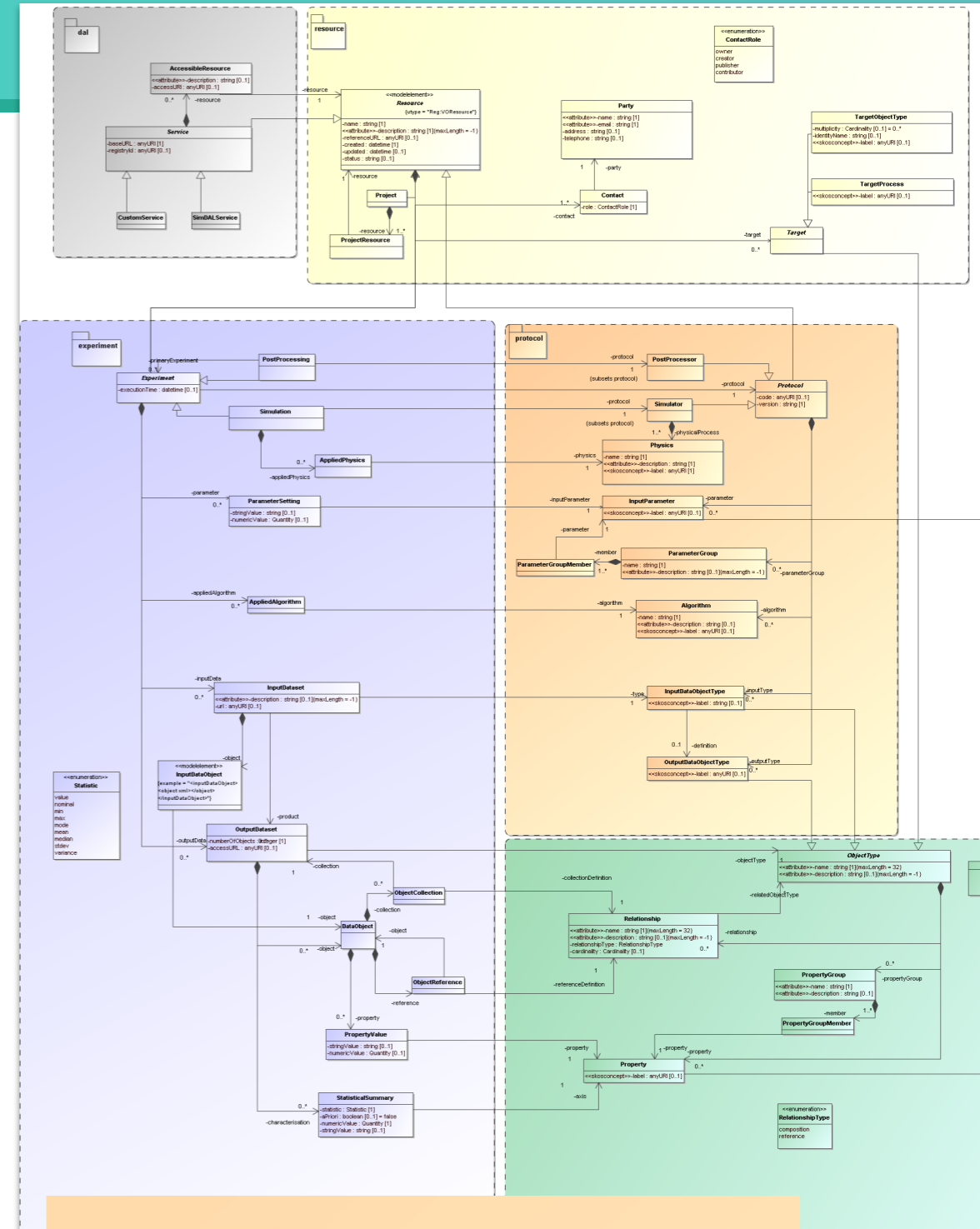
Nom courant

Synonymes

Vocabulaires SKOS utilisés dans VO-Theory:

Simulation Data Model (SimDM) et Simulation Data Access Layer (SimDAL)

- quantités calculées
- objets ou processus simulés
- algorithmes
- ...



Vocabulaires pour VO-Theory

Vocabulaires VO-Theory

- **Algorithms**

Runge-Kutta, Burlish-Stoer, ...

- **Physical processes**

Ex: turbulence, gravitation, ...

- **Physical quantities**

Ex: Velocity, Mass, ...

- **Data Objects Types**

Ex: mesh cell, ...

- **Astronomical Objects**

→ *Dégradation de l'ontologie (OWL) en SKOS*

Chaque concept est défini par une URI:
(identifiant unique)

<http://ivoa.net/rdf/theory/Algorithms#ForwardTimeCentralSpace>

Pref: Forward-Time Central Space
ALT: FTCS
Broader: Finite Difference
Related: Lax-Friedrichs

~ 700 concepts

Loin d'être exhaustif

Forward-Time Central-Space

Finite difference method used to solve parabolic partial differential equations. The method is first-order, explicit and conditionally stable ("Computational Fluid Mechanics and Heat Transfer 2nd ed.", John C. Tannehill, Dale A. Anderson, Richard H. Pletcher, 1997).

<http://purl.obspm.fr/vocab/Algorithms/ForwardTimeCentralSpace>

AltLabels

[FTCS \(en\)](#)

Broader concepts

[Algorithm](#)

[Finite Difference](#)

Broader Transitive concepts

[Algorithm](#)

[Finite Difference](#)

Related concepts

[Lax-Friedrichs](#)

Vocabulaires pour VO-Theory

En 2018-2019

- intégration de ces vocabulaires dans les initiatives du groupe Semantics de l'IVOA
- remplacement de purl.org par ivoa.net

ivoa.net/rdf/theory/Vocabulary#Concept

- en cours: publication des vocabulaires sur le site de l'IVOA

Exemple de vocabulaires:

```
<skos:Concept rdf:about="http://ivoa.net/rdf/theory/PhysicalProcesses#CurrentSheet">~
Δ <skos:prefLabel xml:lang="en">Current Sheet</skos:prefLabel>~
Δ <hasVersion xmlns="http://purl.org/dc/terms/" rdf:datatype="http://www.w3.org/2001/XMLSchema#int">3</hasVersion>~
Δ <modified xmlns="http://purl.org/dc/terms/" rdf:datatype="http://www.w3.org/2001/XMLSchema#dateTime">2011-10-24T13:48:17Z</modified>~
Δ <contributor xmlns="http://purl.org/dc/elements/1.1/">Franck Le Petit</contributor>~
Δ <creator xmlns="http://purl.org/dc/elements/1.1/">Franck Le Petit</creator>~
Δ <date xmlns="http://purl.org/dc/elements/1.1/" rdf:datatype="http://www.w3.org/2001/XMLSchema#dateTime">2011-10-24T13:48:10Z</date>~
</skos:Concept>~
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Δ <skos:prefLabel xml:lang="en">Birkeland Current Sheet</skos:prefLabel>~
Δ <hasVersion xmlns="http://purl.org/dc/terms/" rdf:datatype="http://www.w3.org/2001/XMLSchema#int">3</hasVersion>~
Δ <modified xmlns="http://purl.org/dc/terms/" rdf:datatype="http://www.w3.org/2001/XMLSchema#dateTime">2011-10-24T13:50:36Z</modified>~
Δ <contributor xmlns="http://purl.org/dc/elements/1.1/">Franck Le Petit</contributor>~
Δ <creator xmlns="http://purl.org/dc/elements/1.1/">Franck Le Petit</creator>~
Δ <date xmlns="http://purl.org/dc/elements/1.1/" rdf:datatype="http://www.w3.org/2001/XMLSchema#dateTime">2011-10-24T13:50:31Z</date>~
</skos:Concept>~
<skos:Concept rdf:about="http://ivoa.net/rdf/theory/PhysicalProcesses#RingCurrent">~
Δ <skos:prefLabel xml:lang="en">Ring Current</skos:prefLabel>~
Δ <hasVersion xmlns="http://purl.org/dc/terms/" rdf:datatype="http://www.w3.org/2001/XMLSchema#int">3</hasVersion>~
Δ <modified xmlns="http://purl.org/dc/terms/" rdf:datatype="http://www.w3.org/2001/XMLSchema#dateTime">2011-10-24T13:50:56Z</modified>~
Δ <contributor xmlns="http://purl.org/dc/elements/1.1/">Franck Le Petit</contributor>~
Δ <creator xmlns="http://purl.org/dc/elements/1.1/">Franck Le Petit</creator>~
Δ <date xmlns="http://purl.org/dc/elements/1.1/" rdf:datatype="http://www.w3.org/2001/XMLSchema#dateTime">2011-10-24T13:50:53Z</date>~
</skos:Concept>~
```

Vocabulaires pour VO-Theory

Refonte de l'outil de recherche (par des humains) des concepts:

<http://votheory.obspm.fr>

Home

Search concepts

Help

This service is dedicated to scientists and VO developers who wish to publish theoretical services described by [the Simulation DataModel](#).

As described in the [IVOA](#) standard, Simulation Data Model, registrations of theoretical services, require to provide several URIs corresponding to semantics keywords describing services and simulations. VO-Theory concepts are based on SKOS description as recommended by [the IVOA Semantic Working Group](#).

This website is dedicated to the discovery of these URIs. Navigate through the broader, narrower, related terms to discover the most precise concept you wish.

To suggest new concepts or corrections, contact : support.votheory@obspm.fr.



Search concepts

David Languignon ¹, Franck Lepetit ¹, Nicolas Moreau ¹, Zakaria Meliani ², Fabrice Roy ², Norman Gray ³,
Sebastien Derriere ⁴, Carlos Rodrigo ⁵,

¹[LERMA - Obs. Paris](#), ²[LUTH - Obs. Paris](#), ³[University of Glasgow](#), ⁴[Centre de Données astronomiques de Strasbourg](#), ⁵[CAB/INTA-CSIC/SVO](#)

Vocabulaires pour VO-Theory

Discover concepts and relations:

Home Search concepts Help

[IVOA vocabularies](#) | [Specific vocabularies](#)

They are high level metadata necessary to describe the astrophysical theoretical data and parameter sets. These vocabularies are accepted by IVOA.

Algorithms

Vocabulary that defines numerical methods in use to obtains the data results.

Concepts

Quick search

3+1 Formalism 8-Wave Scheme Accelerated Lambda Iteration
Adaptive Mesh Refinement Advection Upstream Splitting Method
Algorithm Alternating Direction Implicit BiConjugate Gradient
BiConjugate Gradient Stabilized Block Based AMR
Bulirsch-Stoer Cell Based AMR Cell Centred
Central Difference Scheme Chebyshev Iteration
Conjugate Gradient Method Conjugate Gradient Squared Method
Constrained Transport Coupled Escaped Probability
Crank-Nicolson Discontinuous Galerkin
Discontinuous Galerkin methods Escape Probability Euler
Exact Radiative Transfer Method Exact Riemann Solver
Extended Finite Element Method Fast-Multipole Method
Finite Difference Finite Element Finite Volume
Finite element limit analysis Fokker-Planck Solver
Forward-Time Central-Space Fourier Technique
Friends-Of-Friends Galerkin Method Gauss-Seidel

Coupled Escaped Probability

Exact method for line radiative transfer ("A new exact method for line radiative transfer", Elitzur, M., & Asensio Ramos, A. 2006, MNRAS, 365, 779).

<http://ivoa.net/rdf/theory/Algorithms#CoupledEscapedProbability>

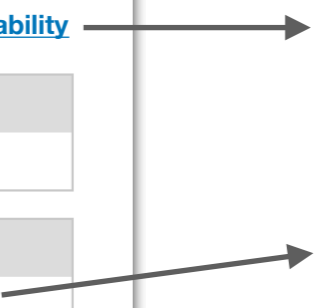
AltLabels
CEP (en)

Broader concepts
Algorithm
Escape Probability

Broader Transitive concepts
Algorithm

URI

Relations



Vocabulaires pour VO-Theory



I
V
O
A

ivoa.net/rdf/theory

List of vocabularies:

- Algorithms
- Data Object Types
- Physical processes
- Physical quantities
- Astronomical Objects



P
A
R
I
S

<http://votheory.obspm.fr>

Copy of vocabularies

+ **application** to:

- 1 - discover concept
- 2 - navigation in relations
- 3 - check existence

Vocabulaires pour VO-Theory



I
V
O
A

ivoa.net/rdf/theory

List of vocabularies:

- Algorithms
- Data Object Types
- Physical processes
- Physical quantities
- Astronomical Objects



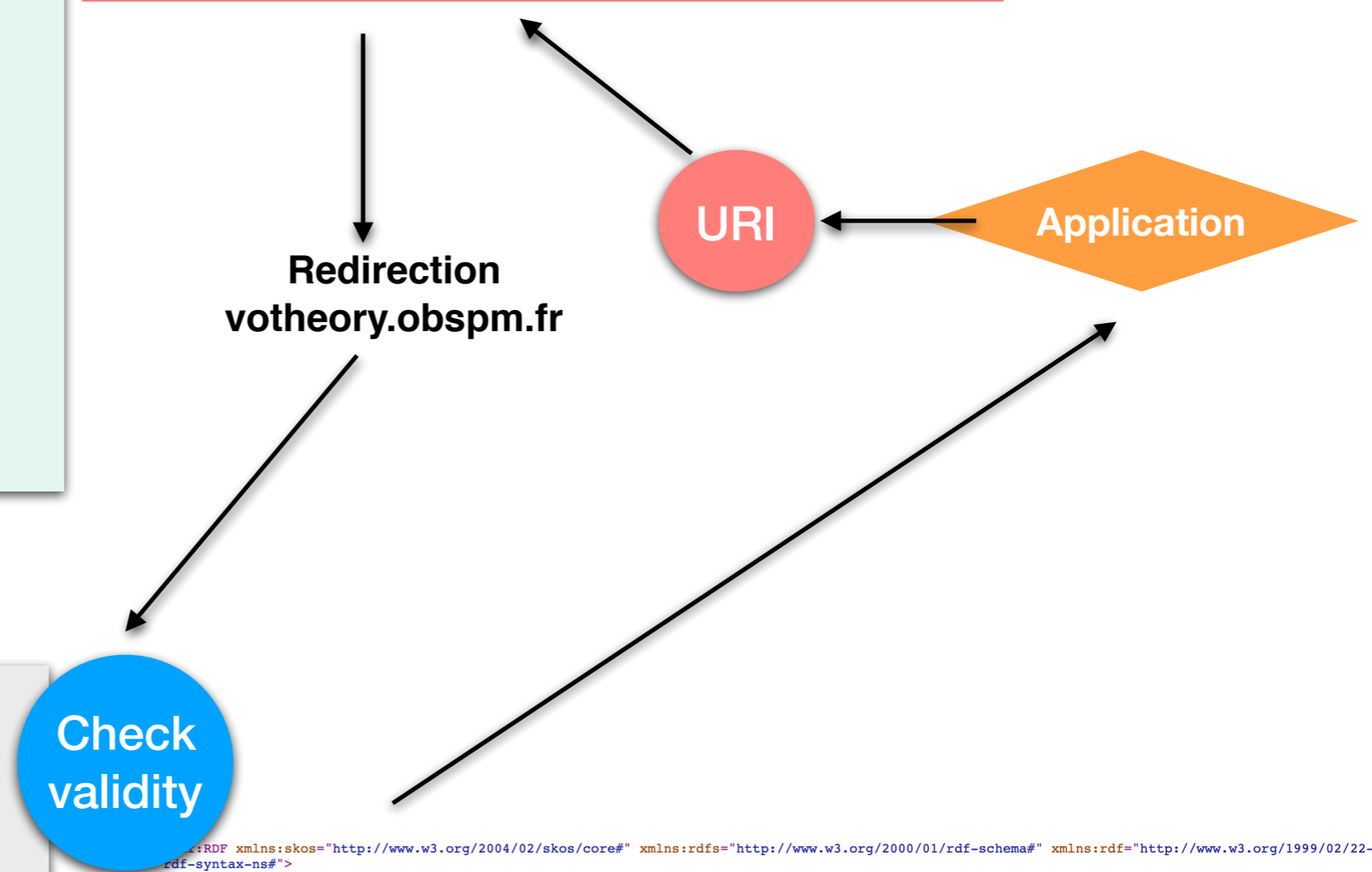
P
A
R
I
S

<http://votheory.obspm.fr>

Copy of vocabularies
+ **application** to:

- 1 - discover concept
- 2 - navigation in relations
- 3 - check existence

ivoa.net/rdf/theory/vocabulary#Concept



```

<rdf:RDF xmlns:skos="http://www.w3.org/2004/02/skos/core#" xmlns:rdfs="http://www.w3.org/2000/01/rdf-schema#" xmlns:rdf="http://www.w3.org/1999/02/22-
rdf-syntax-ns#">
  <skos:Concept rdf:about="http://purl.obspm.fr/vocab/Algorithms/CoupledEscapedProbability">
    <skos:prefLabel xml:lang="en">Coupled Escaped Probability</skos:prefLabel>
    <skos:definition xml:lang="en">
      Exact method for line radiative transfer ("A new exact method for line radiative transfer", Elitzur, M., & Asensio Ramos, A. 2006, MNRAS, 365,
      779).
    </skos:definition>
    <hasVersion xmlns="http://purl.obspm.fr/dc/terms/" rdf:datatype="http://www.w3.org/2001/XMLSchema#int">8</hasVersion>
    <modified xmlns="http://purl.obspm.fr/dc/terms/" rdf:datatype="http://www.w3.org/2001/XMLSchema#dateTime">2011-04-27T12:12:47Z</modified>
    <skos:altLabel xml:lang="en">CEP</skos:altLabel>
    <skos:broader rdf:resource="http://purl.obspm.fr/vocab/Algorithms/Algorithm"/>
    <skos:broader rdf:resource="http://purl.obspm.fr/vocab/Algorithms/EscapeProbability"/>
    <skos:broaderTransitive rdf:resource="http://purl.obspm.fr/vocab/Algorithms/Algorithm"/>
    <contributor xmlns="http://purl.obspm.fr/dc/terms/">roy</contributor>
    <creator xmlns="http://purl.obspm.fr/dc/terms/">roy</creator>
    <created xmlns="http://purl.obspm.fr/dc/terms/" rdf:datatype="http://www.w3.org/2001/XMLSchema#dateTime">2010-09-14T14:12:43Z</created>
  </skos:Concept>
</rdf:RDF>
  
```

Vocabulaires pour VO-Theory

Discover concepts and relations:

This XML file does not appear to have any style information associated with it. The document tree is shown below.

```
<rdf:RDF xmlns:skos="http://www.w3.org/2004/02/skos/core#" xmlns:rdfs="http://www.w3.org/2000/01/rdf-schema#" xmlns:rdf="http://www.w3.org/1999/02/22-rdf-syntax-ns#">
  <skos:Concept rdf:about="http://purl.obspm.fr/vocab/Algorithms/CoupledEscapedProbability">
    <skos:prefLabel xml:lang="en">Coupled Escaped Probability</skos:prefLabel>
    <skos:definition xml:lang="en">
      Exact method for line radiative transfer ("A new exact method for line radiative transfer", Elitzur, M., & Asensio Ramos, A. 2006, MNRAS, 365, 779).
    </skos:definition>
    <hasVersion xmlns="http://purl.obspm.fr/dc/terms/" rdf:datatype="http://www.w3.org/2001/XMLSchema#int">8</hasVersion>
    <modified xmlns="http://purl.obspm.fr/dc/terms/" rdf:datatype="http://www.w3.org/2001/XMLSchema#dateTime">2011-04-27T12:12:47Z</modified>
    <skos:altLabel xml:lang="en">CEP</skos:altLabel>
    <skos:broader rdf:resource="http://purl.obspm.fr/vocab/Algorithms/Algorithm"/>
    <skos:broader rdf:resource="http://purl.obspm.fr/vocab/Algorithms/EscapeProbability"/>
    <skos:broaderTransitive rdf:resource="http://purl.obspm.fr/vocab/Algorithms/Algorithm"/>
    <contributor xmlns="http://purl.obspm.fr/dc/terms/">roy</contributor>
    <creator xmlns="http://purl.obspm.fr/dc/terms/">roy</creator>
    <created xmlns="http://purl.obspm.fr/dc/terms/" rdf:datatype="http://www.w3.org/2001/XMLSchema#dateTime">2010-09-14T14:12:43Z</created>
  </skos:Concept>
</rdf:RDF>
```

Pour suggérer des concepts:
support.votheory@obspm.fr

Vocabulaires spécifiques et applications: ISMDB

Applications / Services: besoin de plus souplesse qu'un vocabulaire contrôlé ne l'autorise

ANO5 Plateforme MIS & Jets - ISMDB

Modèle PDR: calcule plusieurs centaines de milliers de quantités

- toutes caractérisées par des SKOS concepts
- certaines quantités sont trop spécifiques pour être dans un vocabulaire "officiel"

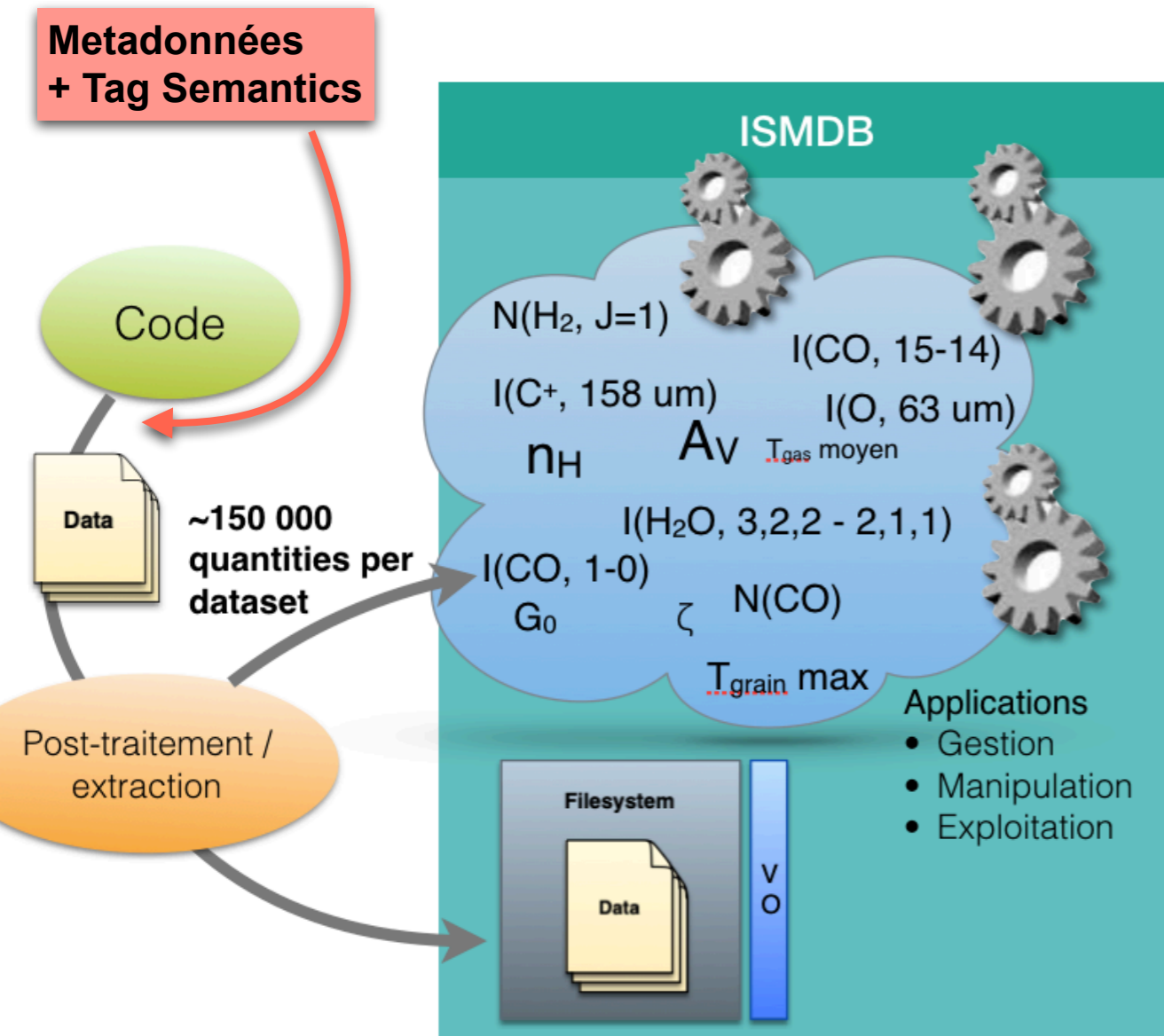
Exemples de concepts spécifiques à un domaine ou de concepts fins dans ISMDB:

- taux d'ionisation par les rayons cosmiques
- champ UV moyen, G_0
- intensité de la raie CO 3-2
- colonne de densité de CO dans son état $J = 1$

Vocabulaires spécifiques pour le code PDR

- Comporte : ~ 300 000 termes
- avec des **synonymes**

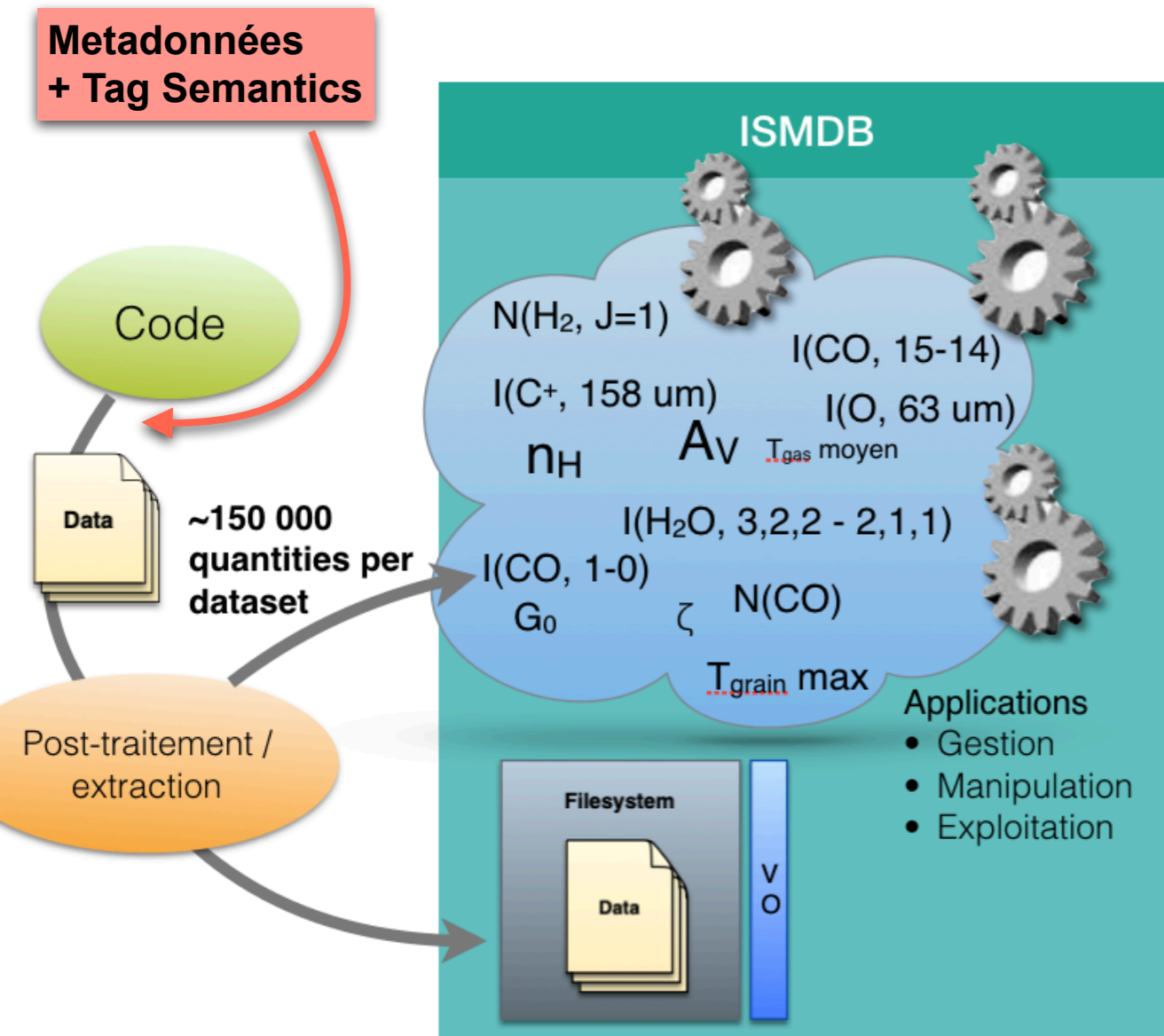
Vocabulaires spécifiques et applications: ISMDB



→ Base de données à **haute dimension**

→ Interrogations de la base sur les 150 000 quantités

Vocabulaires spécifiques et applications: ISMDB



→ Base de données à **haute dimension**

→ Interrogations de la base sur les 150 000 quantités

Interface classique (ex: VLA)

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 JVA: 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
 RA or Longitude: (04h33m11.1s or 68.29d)
 DEC or Latitude: (05d21'15.5" or 5.352d)
 Search Radius: 1.0" (1d00'00" or 0.2d)
 Min. Exposure: (secs)
 Equinox: J2000

Check for automatic VLA field-of-view, freq. dependent.??

Observing Configurations Search :

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

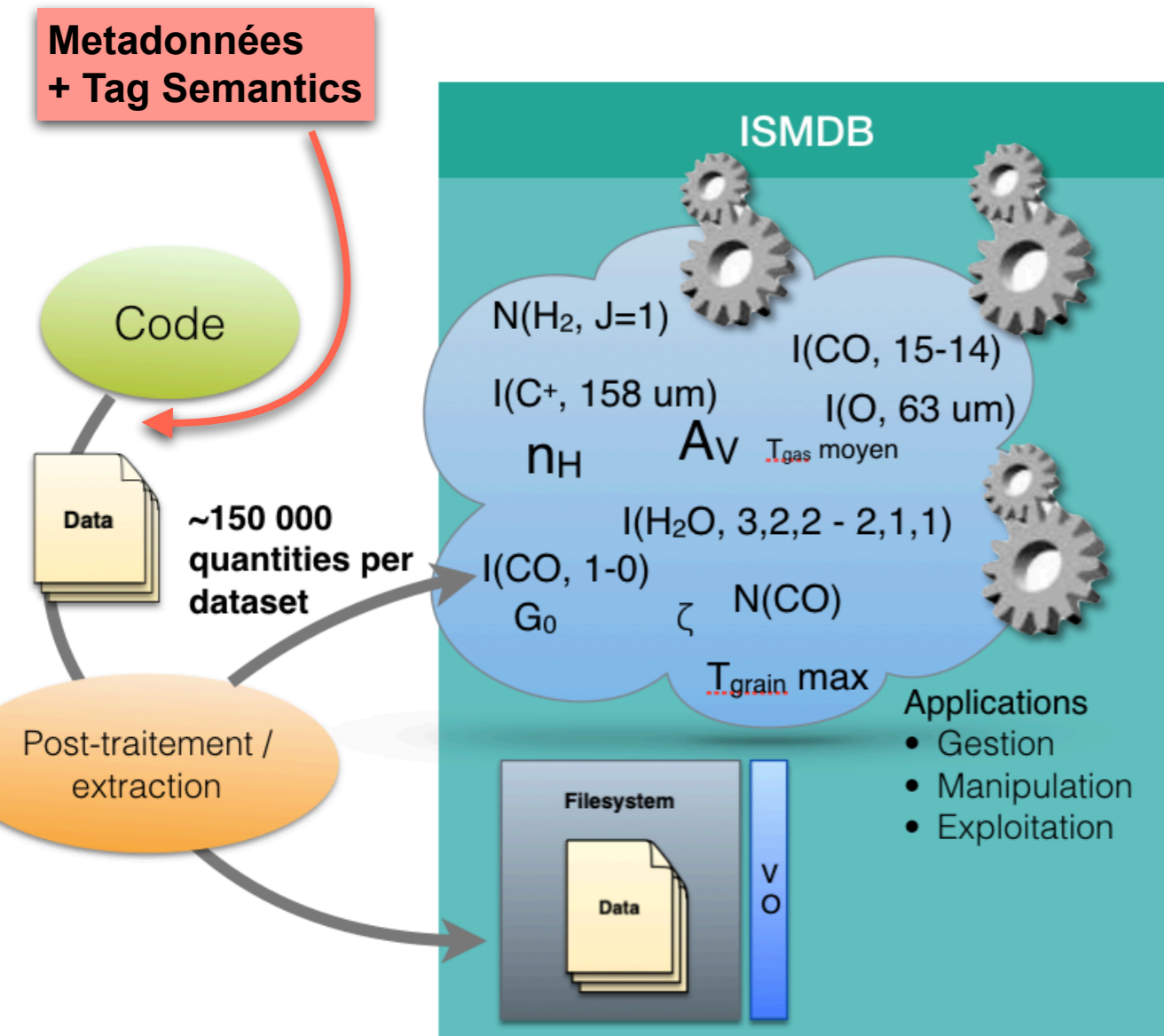
Observing Bands: All 4 P L S C
 X U K Ka Q W
 Frequency Range: (In MHz : 1665.401 - 1720.500)

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

Pour ISMDB, il faudrait 150 000 champs

Vocabulaires spécifiques et applications: ISMDB



Exemple d'interface de service au-dessus de ISMDB

The screenshot shows the 'ISM Services' web interface, specifically the 'ISM DataBase - Inverse Search service' (Beta). The interface is titled 'Grid of isobaric PDR 1.5.2 models' and dated '2016.12.03'. It is divided into three main sections:

- 1 - search among two parameters**: This section allows users to search for parameters. It includes input fields for 'x' (Pgas_0, cm-3_K) and 'y' (G0 observer side, Mathis_unit), both with 'log scale' checkboxes checked.
- 2 - fix all the other parameters**: This section allows users to fix other parameters. It includes an input field for 'AVmax' (mag) with a value of '10'.
- 3 - observational constraints**: This section allows users to search for available quantities. It includes a search box with the text 'Search for available quantities... Ex: N(H)' and a 'Use' button. Below the search box, there is a list of constraints: $I(\text{CO } v=0, J=1 \rightarrow v=0, J=0 \text{ angle } 00 \text{ deg}) > 1.8\text{E}-7$, $I(\text{CO } v=0, J=1 \rightarrow v=0, J=0 \text{ angle } 00 \text{ deg}) < 2.4\text{E}-7$, $I(\text{H}_2 \text{ } v=0, J=2 \rightarrow v=0, J=0 \text{ angle } 60 \text{ deg}) > 1\text{E}-8$, and $I(\text{H}_2 \text{ } v=0, J=2 \rightarrow v=0, J=0 \text{ angle } 60 \text{ deg}) < 5\text{E}-7$. A 'Search' button is located at the bottom of this section.

→ Base de données à **haute dimension**

→ Interrogations de la base sur les 150 000 quantités

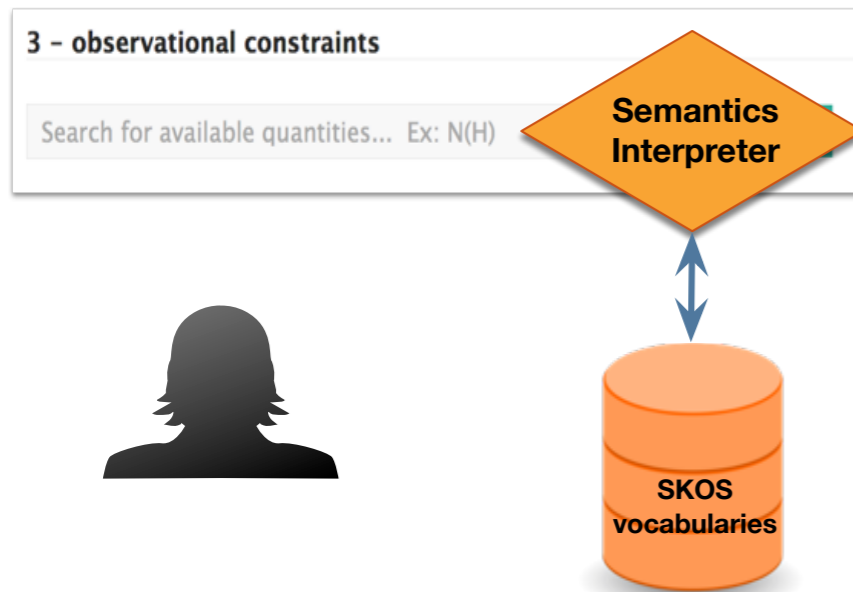
This is a close-up of the '3 - observational constraints' section from the previous screenshot. It shows the search box 'Search for available quantities... Ex: N(H)' and the 'Use' button. A blue arrow points from the 'Semantic interpreter' label below to the search box.

Semantic interpreter

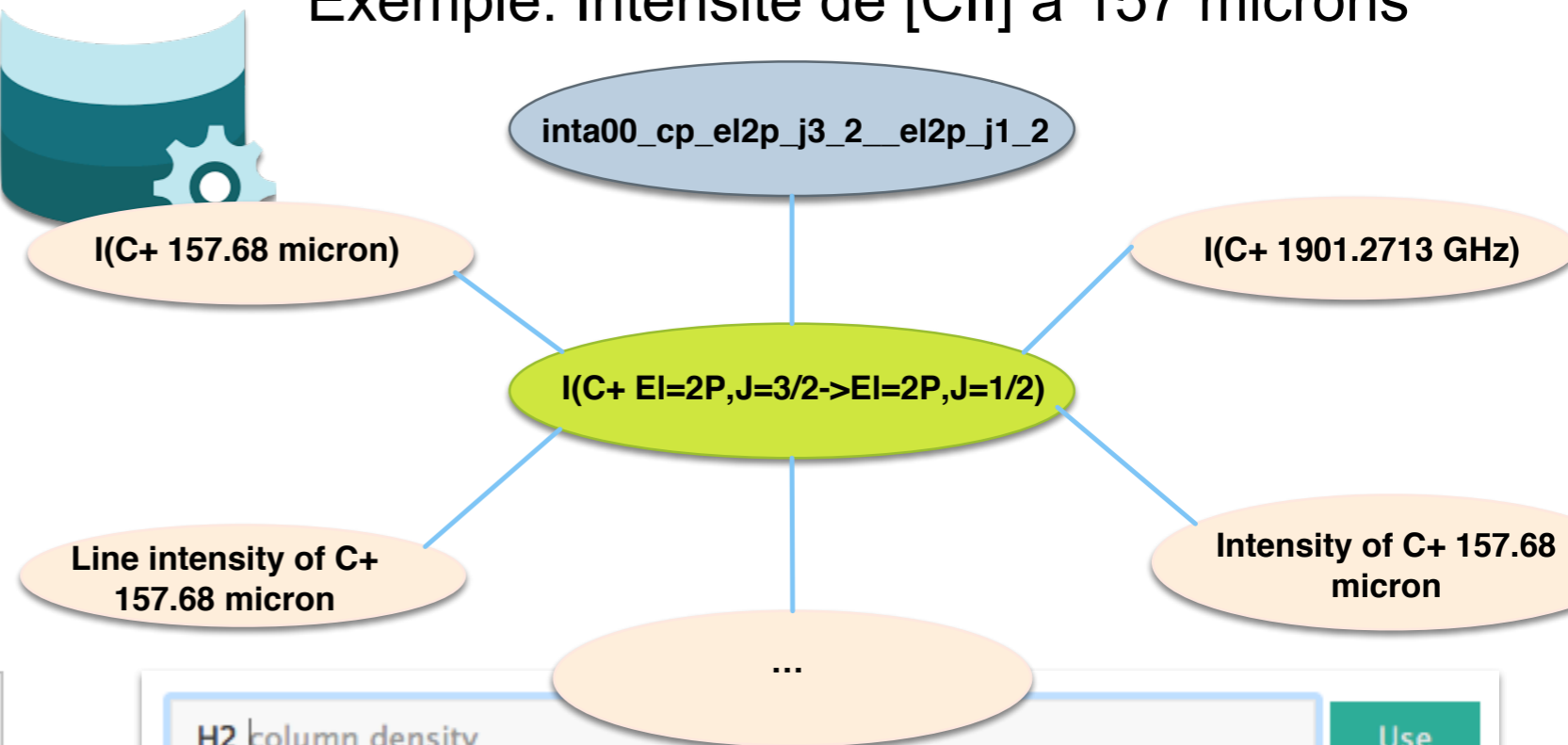
Vocabulaires spécifiques et applications: ISMDB

Besoins de vocabulaires pour les **synonymes**

- L'utilisateur ne peut pas savoir comment les quantités sont nommées dans la base
- Besoin d'un "Semantic Interpreter"



Exemple: Intensité de [CII] à 157 microns



Semantics Interpreter

Semantics

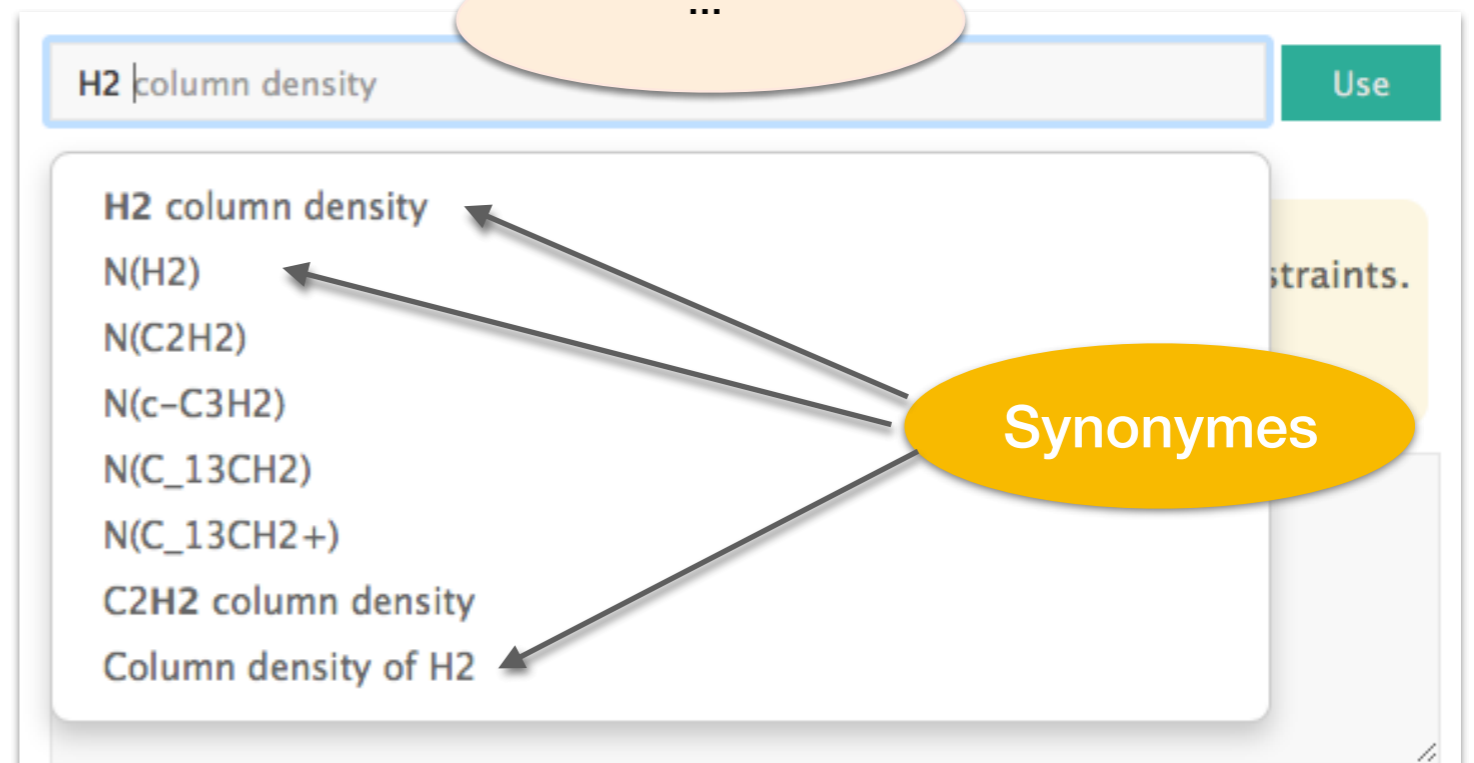
SKOS: PREF + ALT

→ synonyms

+

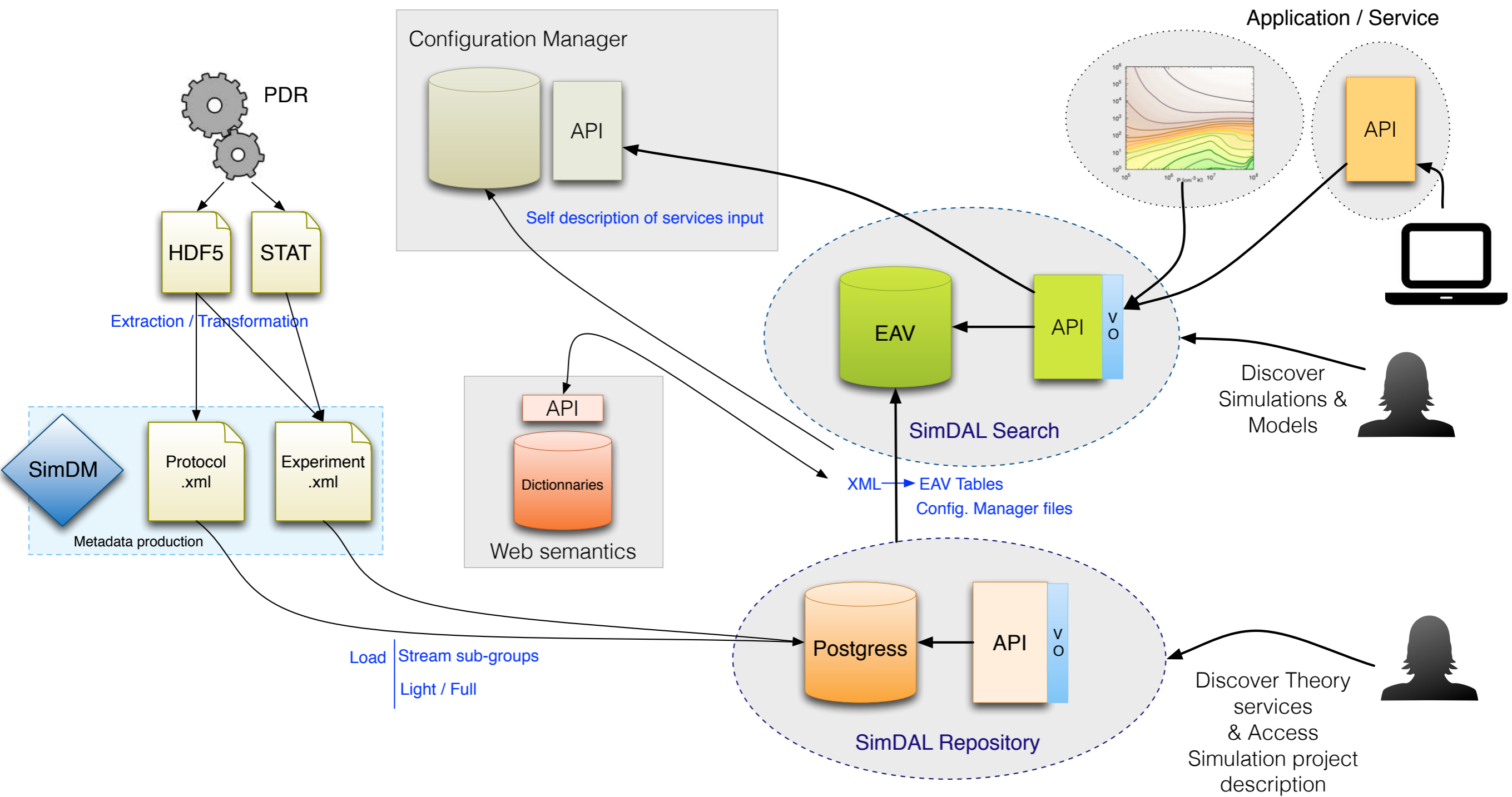
Ranking system

(learn from users)



Vocabulaires spécifiques et applications: ISMDB

Integration du **semantics interpreter** à l'ensemble des services



Conclusions

Importants efforts à l'IVOA sur les aspects Semantic

- UCD
 - Datalink
 - Theory
 - Instruments & télescopes (voir exposé de Mireille)
- Publication uniforme des vocabulaires sur le site de l'IVOA
- Procédures mises en place pour faciliter l'élargissement des vocabulaires

Theory:

- Publications des vocabulaires sur le site de l'IVOA
- Application pour rechercher et valider les concepts: <http://votheory.obspm.fr>

Utilisation de vocabulaires dans des applications

Il est possible d'utiliser les vocabulaires pour faciliter la découverte de données par les utilisateurs

Ex: ISMDB <http://ism.obspm.fr>

