Leibniz-Institut für
Astrophysik Potsdam

A Provenance Data Model for astronomy

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GERMAN ASTROPHYSICAL GAVO VIRTUAL OBSERVATORY

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What is provenance?

- In general: tracking the history, origin of something:
  - art
  - food industry
  - information (data vis) on news webpage
  - scientific data!

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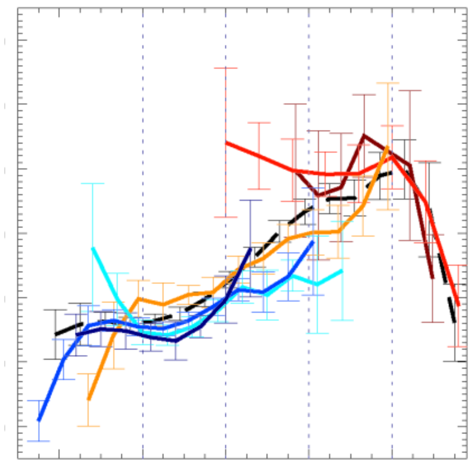


- In astronomy: explain how data sets were produced:
  - Who created the data?
  - Which algorithm was used to produce it?
  - Which steps were undertaken to process the image?
  - Can I get access to the original, uncalibrated files from the observation?

Goals for IVOA Provenance Data Model

- For a given data set, provenance should help to …
  - Discover steps of production

    Aid in reprocessing: Which processing steps have been done already?
  - Give attribution

    Who was involved in the project? Who can I ask about these data?
  - Allow to assess the quality of the data

    Is the dataset suited for my research?
  - Aid in debugging

    Find possible error sources, e.g. check version of processing software, ambient conditions, telescope configuration, parameter settings, …
  - Search in structured provenance metadata

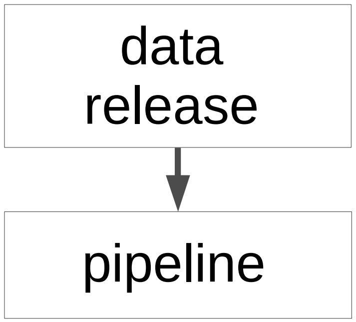
    Includes „forward tracking“: which datasets were produced with the same pipeline version, follow scientific productivity of instruments/telescopes or software usage

Example in astronomy

data
release

- Where is the data coming from?

Example in astronomy



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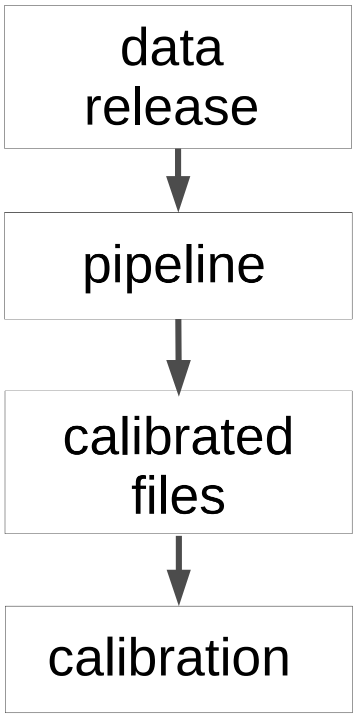
Example in astronomy



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- Have calibrated files been used for the pipeline?
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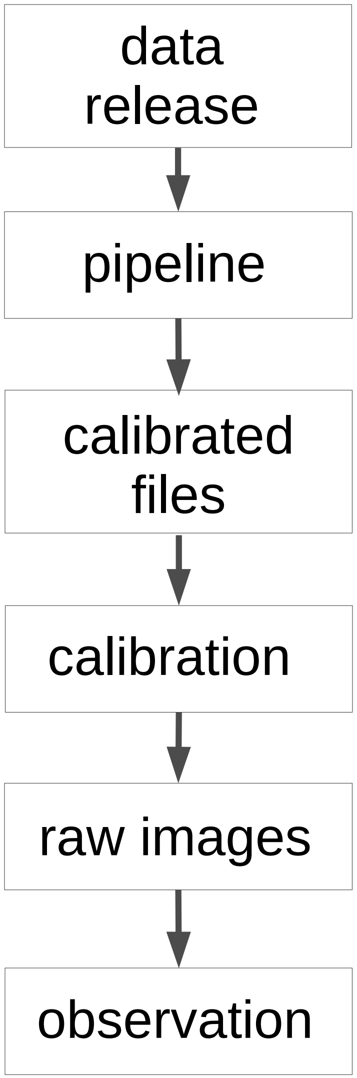

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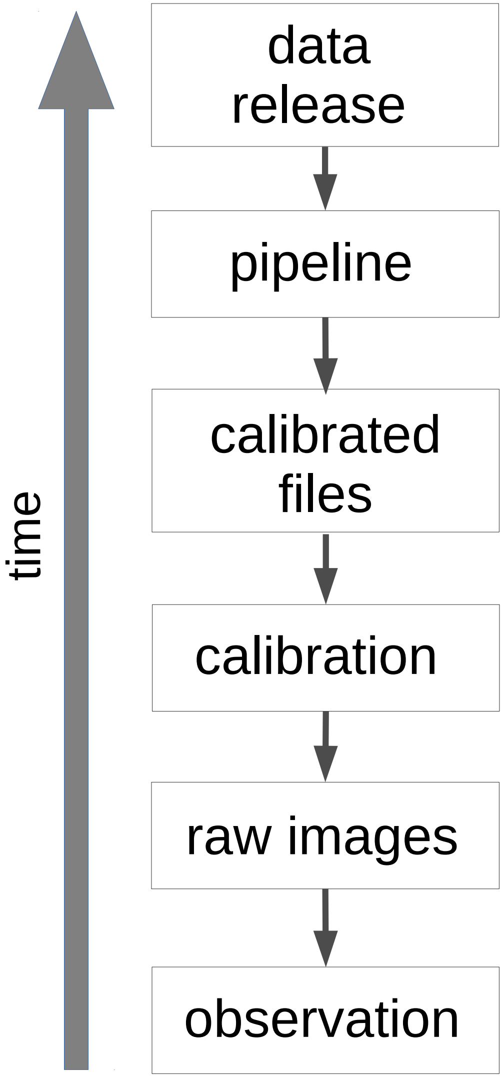

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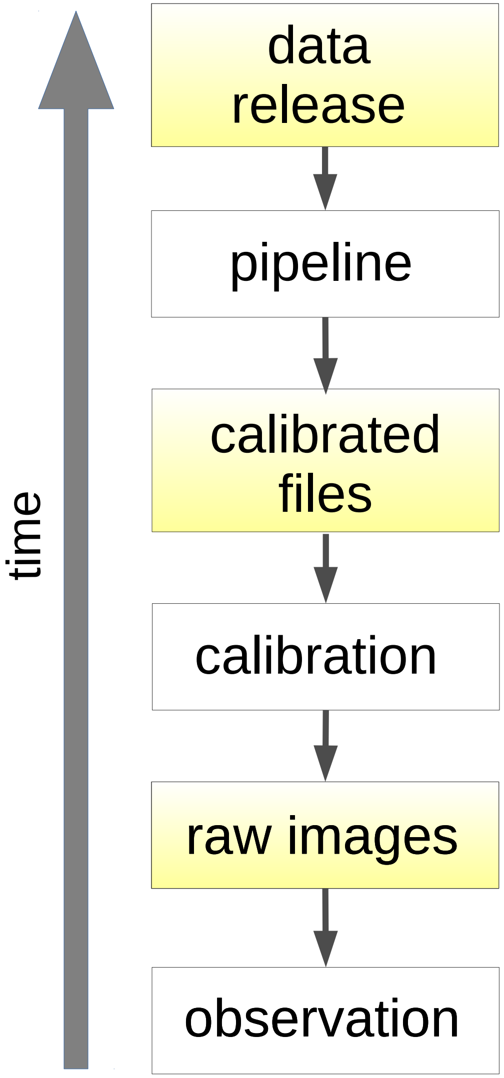
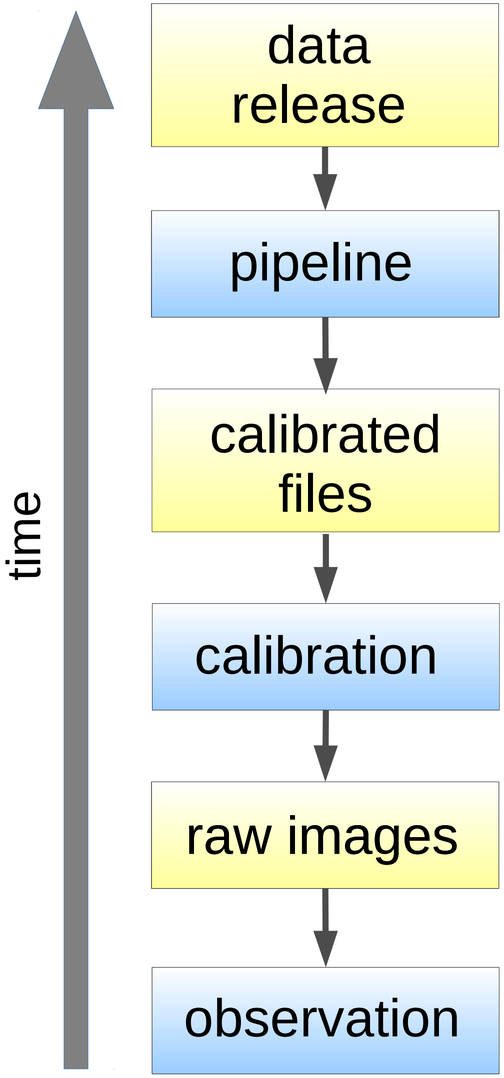
=> Track data back in time

Example in astronomy



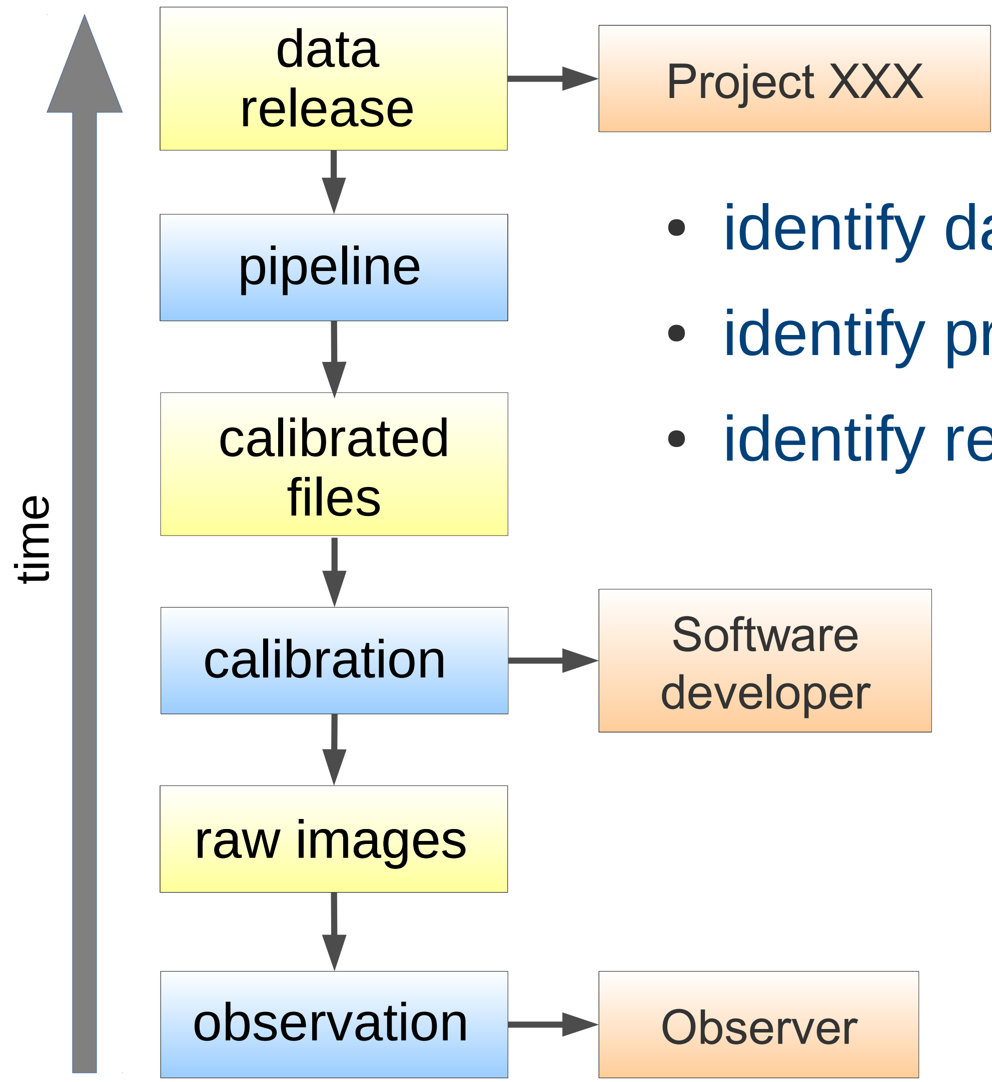
- identify data entities

Example in astronomy



- identify data entities
- identify processes (activities)

Example in astronomy



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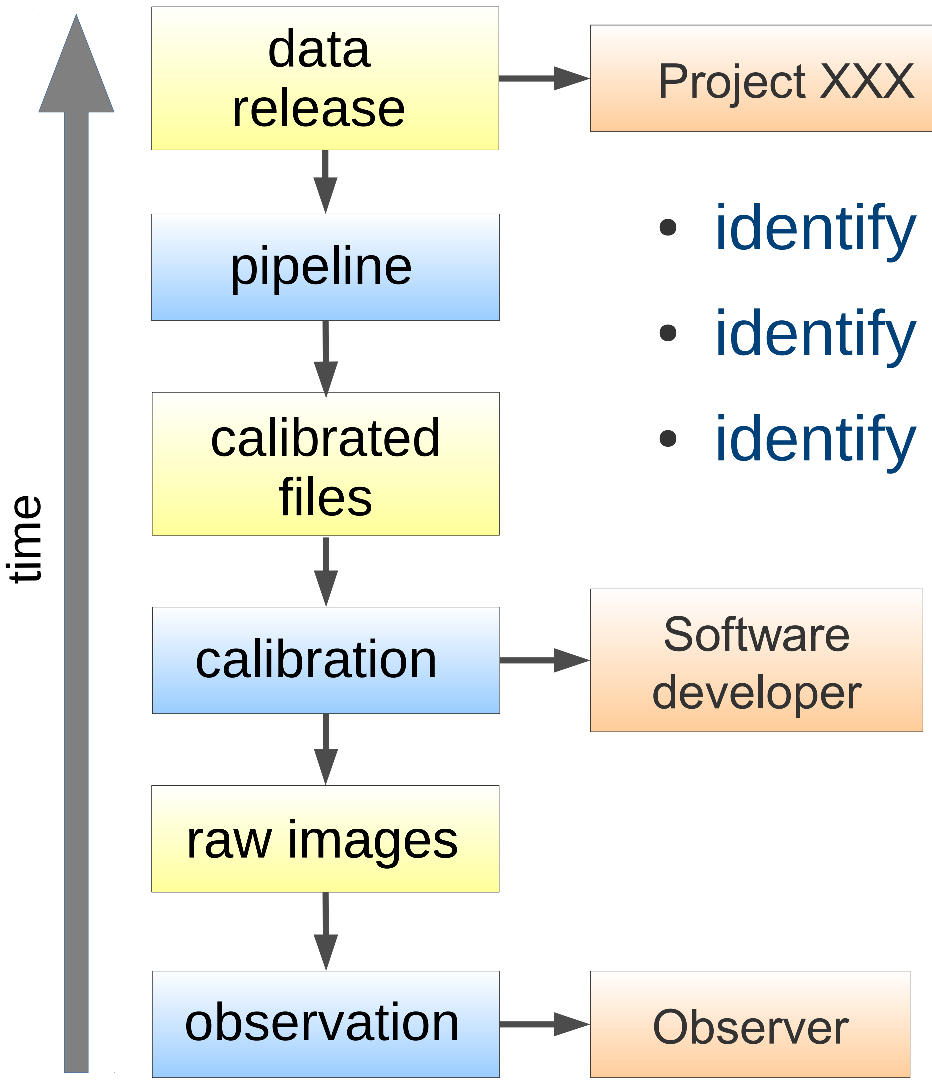
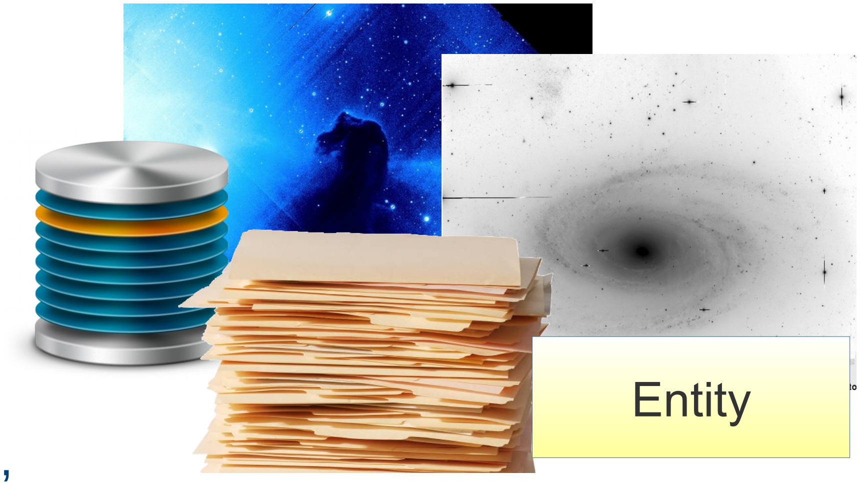


- identify data entities
- identify processes (activities)
- identify responsible people

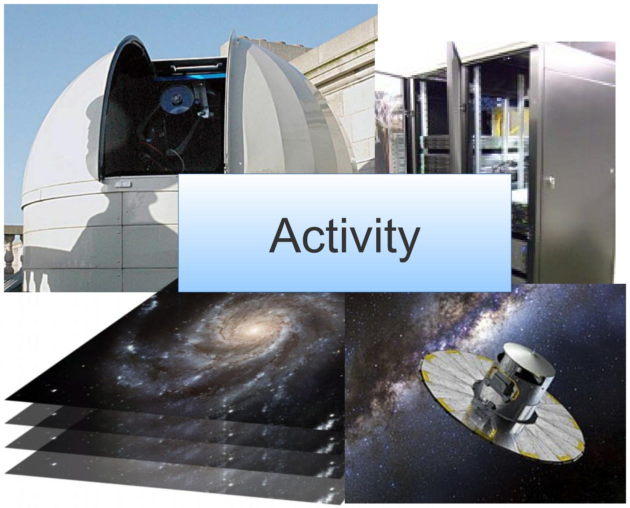
- provenance is defined by the relations between data, activities and the people/projects involved

Examples for core objects

- **Entities (datasets):**
  images, catalogs,
  database tables, spectra,
  log files, parameters, ...



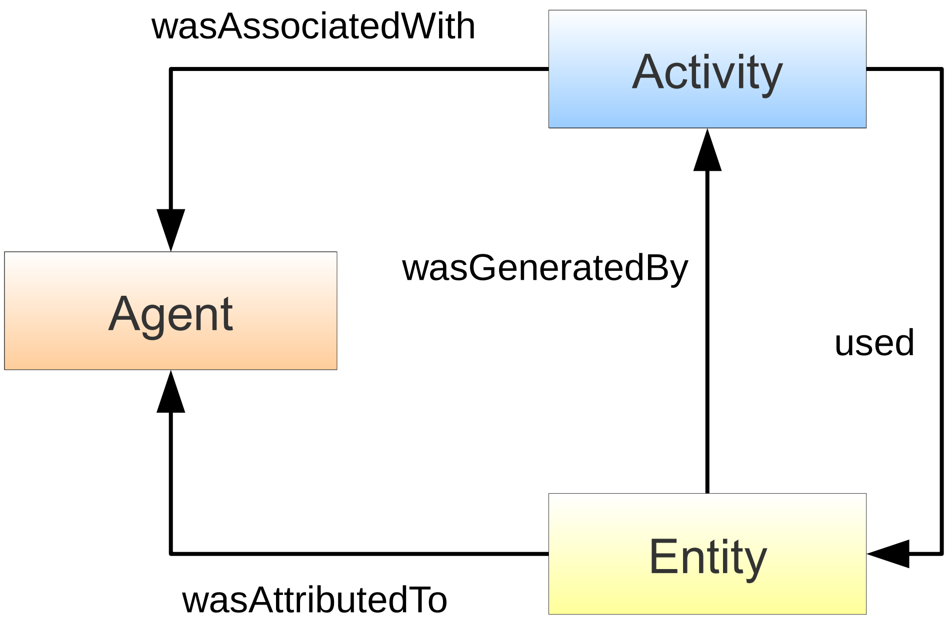
- **Activities:**
  observations;
  processing steps like bias subtraction, image stacking, continuum fit, object extraction; simulations, ...



- **Persons/Organizations:**
  creator, publisher, developer, ...

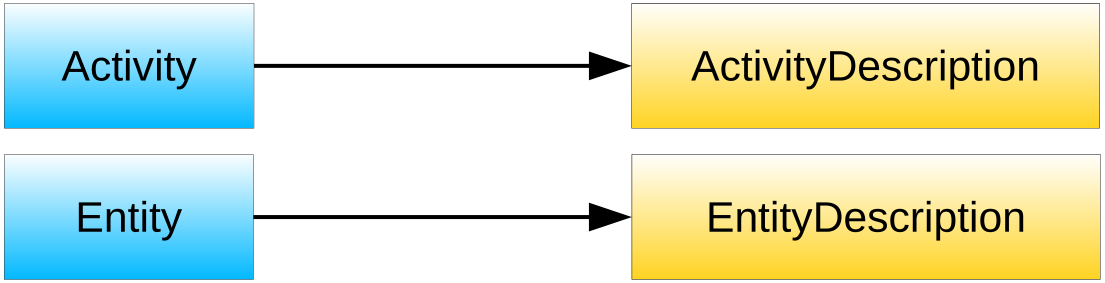
Provenance DM core classes

- same core classes as in W3C ProvDM model:
  - http://www.w3.org/TR/prov-dm/, published 2013
- 3 core classes:
  - Activity
  - Entity
  - Agent
- core relations:
  - used
  - wasGeneratedBy
  - wasAttributedTo
  - wasAssociatedWith



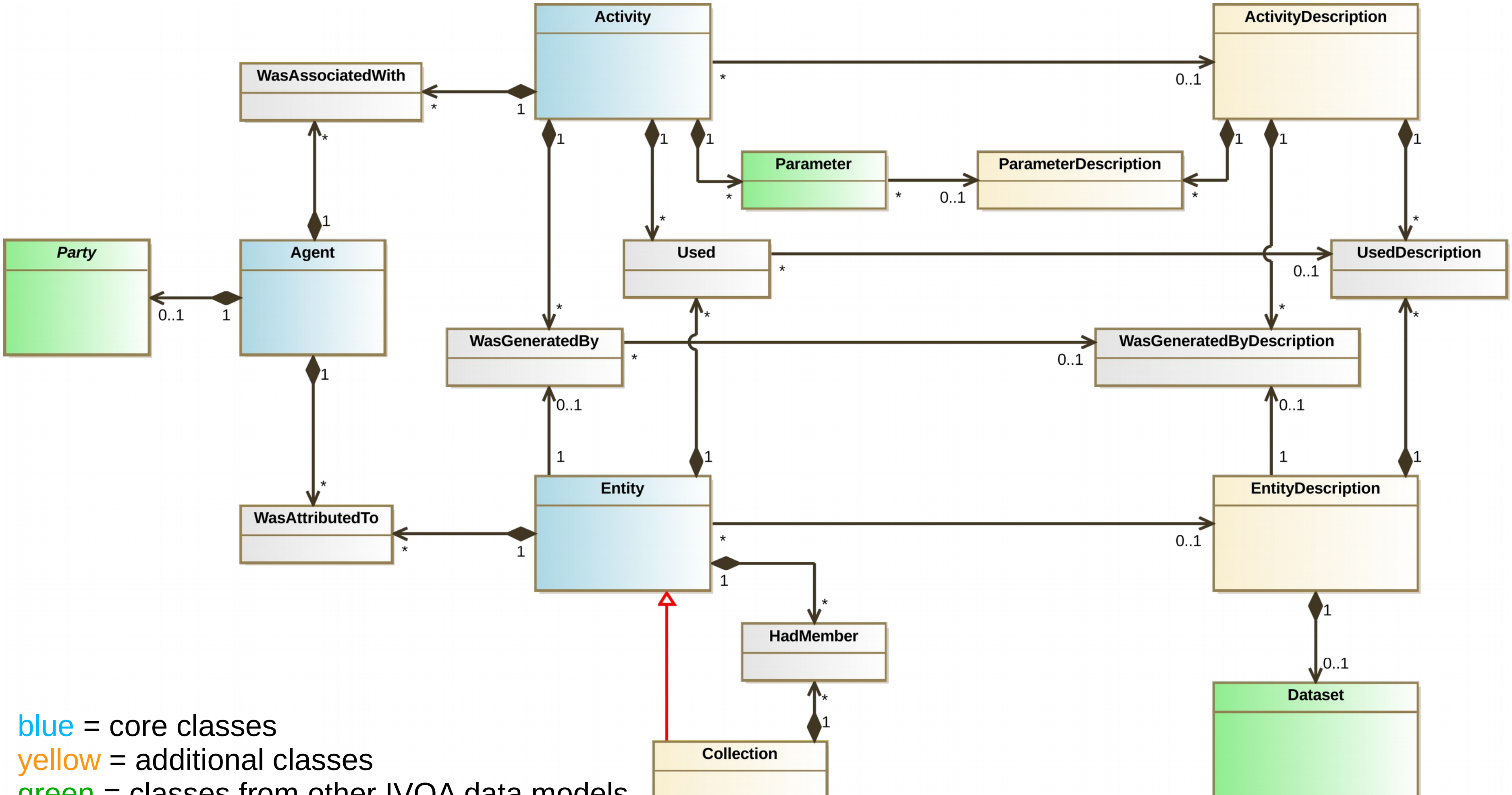
Extending the core

- in astronomy: know most common processes
- introduce new “description” classes for common processes and datatypes:



- connection to similar structures in other data models:
  - Activity => **Experiment** in Simulation Data Model
  - ActivityDescription => **Protocol** in Simulation Data Model
  - EntityDescription => **Dataset** in Dataset Data Model

Overview class diagram from working draft



blue = core classes
yellow = additional classes
green = classes from other IVOA data models
grey = relation classes

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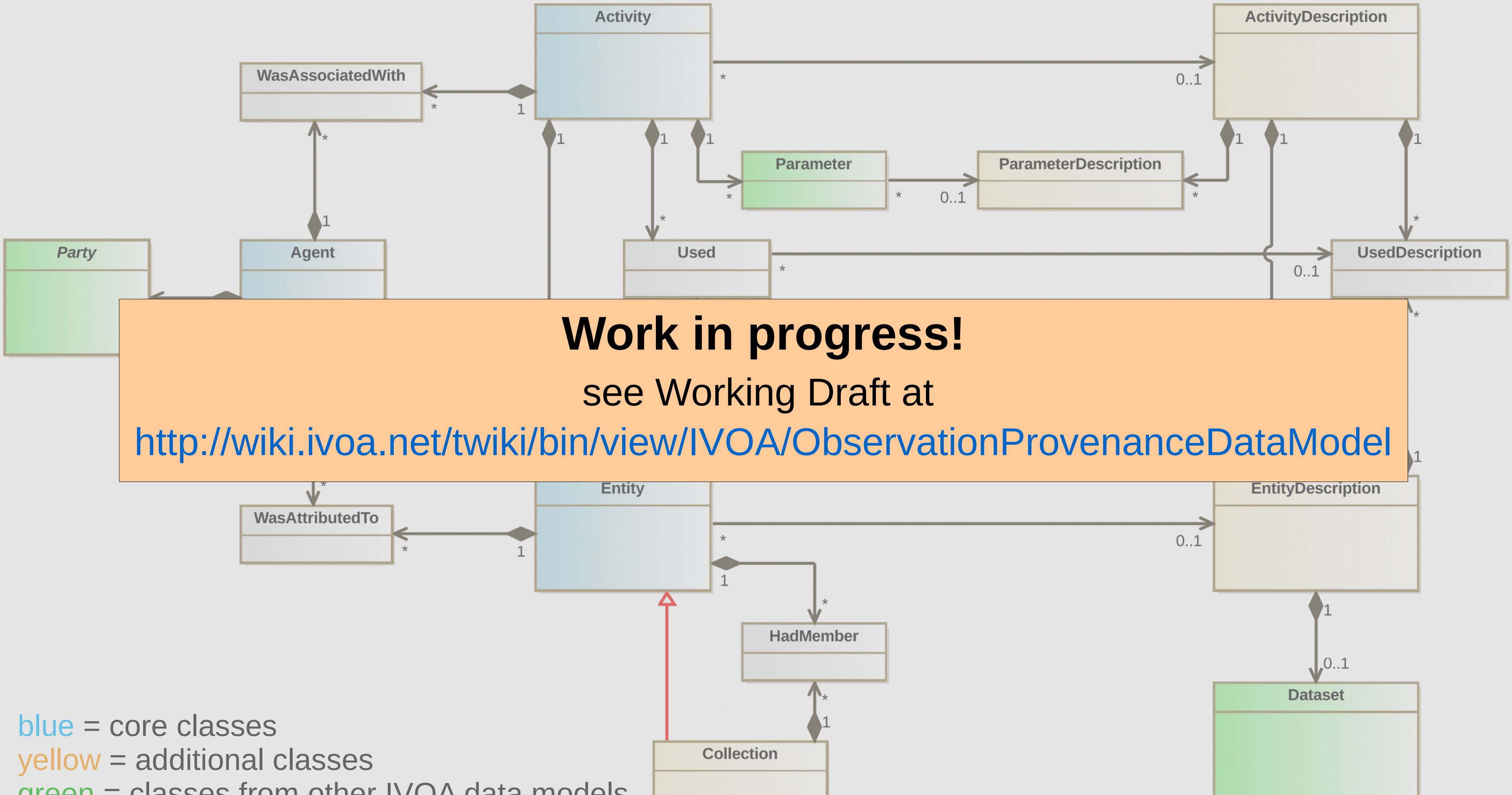

Work in progress!

see Working Draft at

http://wiki.ivoa.net/twiki/bin/view/IVOA/ObservationProvenanceDataModel

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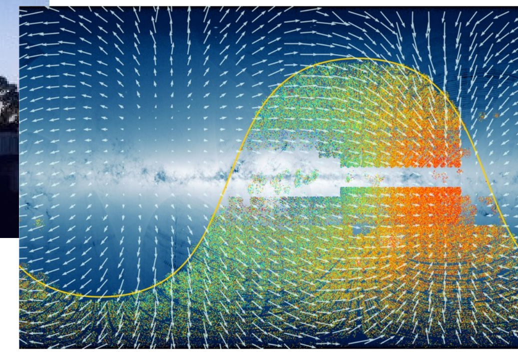
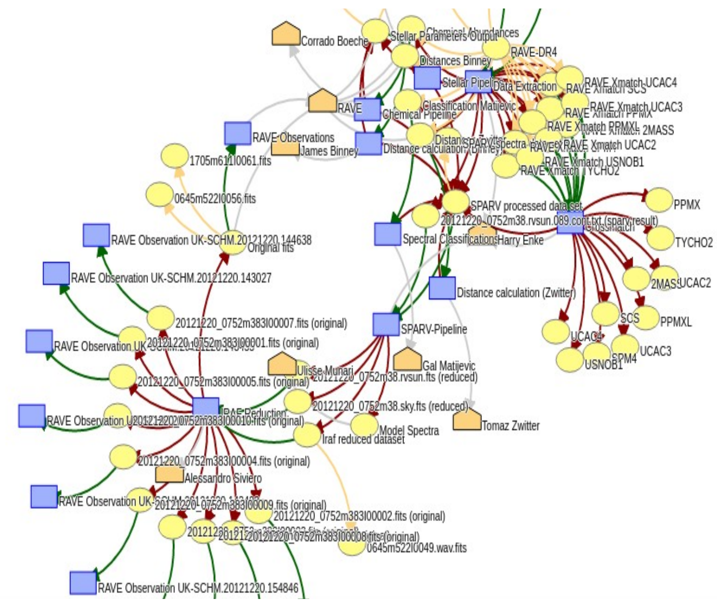
Use case: RAVE

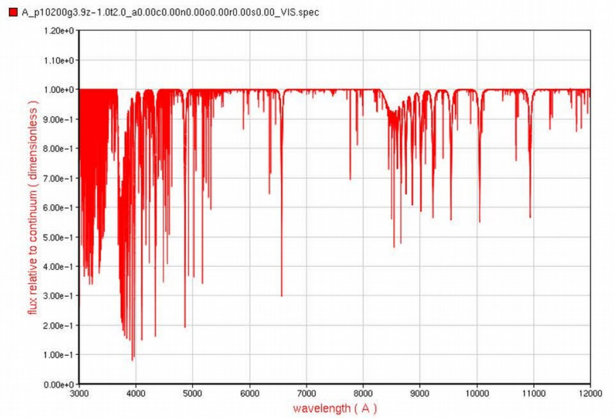


- multi-fibre spectroscopic survey
- radial velocities + derived stellar properties for ~ half million stars
- use provenance to track e.g.
  - Who was responsible for determining the log g values in DR5?
  - Which fibre observed the spectrum for star xyz?
  - Study selection effects using information on intended and actually observed stellar sample

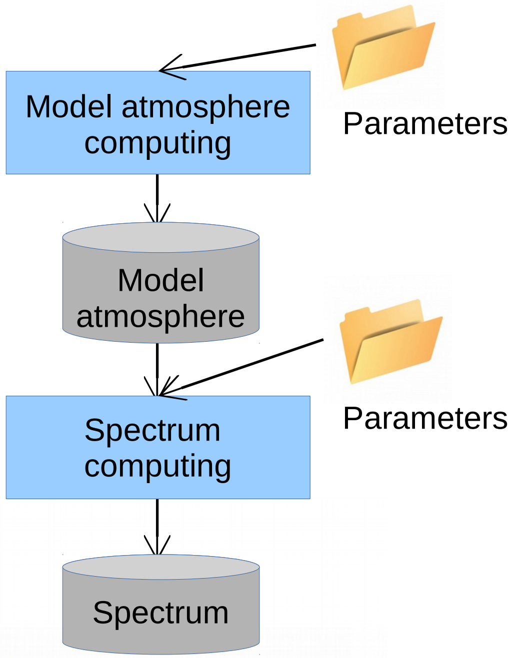


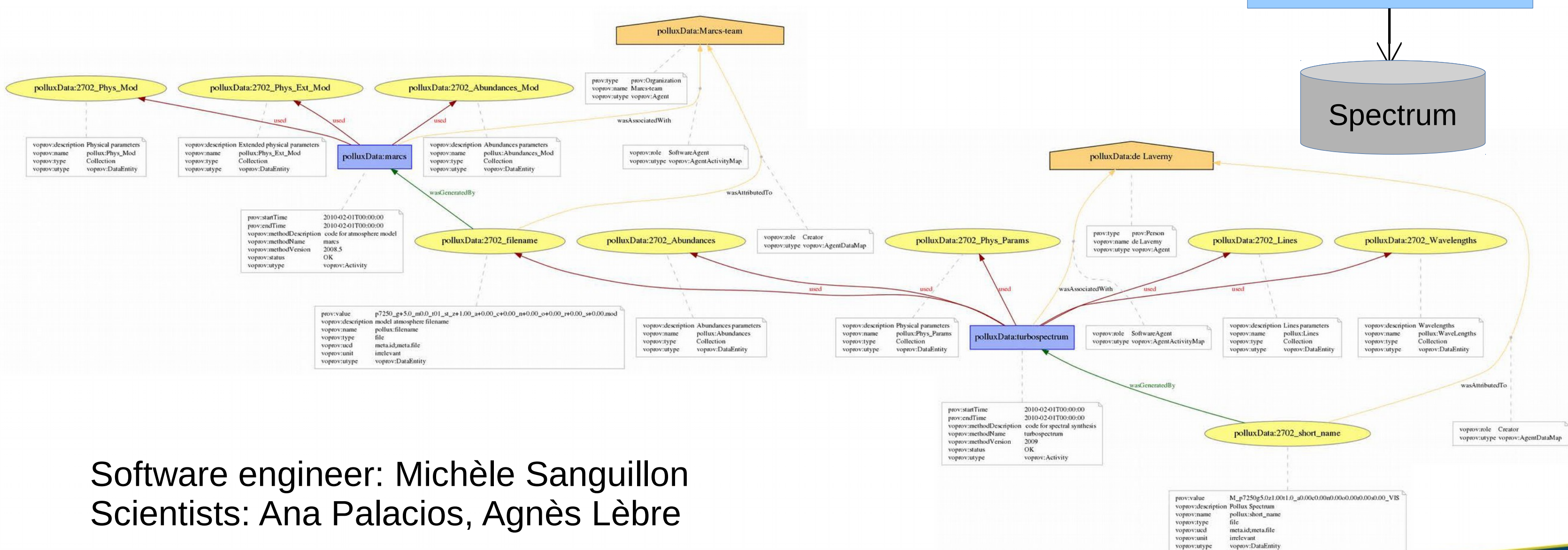
see javacript example at
https://escience.aip.de/prov/graphs/example.html

Use case: Pollux



Database of more than 8000 very high resolution synthetic spectra in optical domain
(3000 Å- 12000 Å)



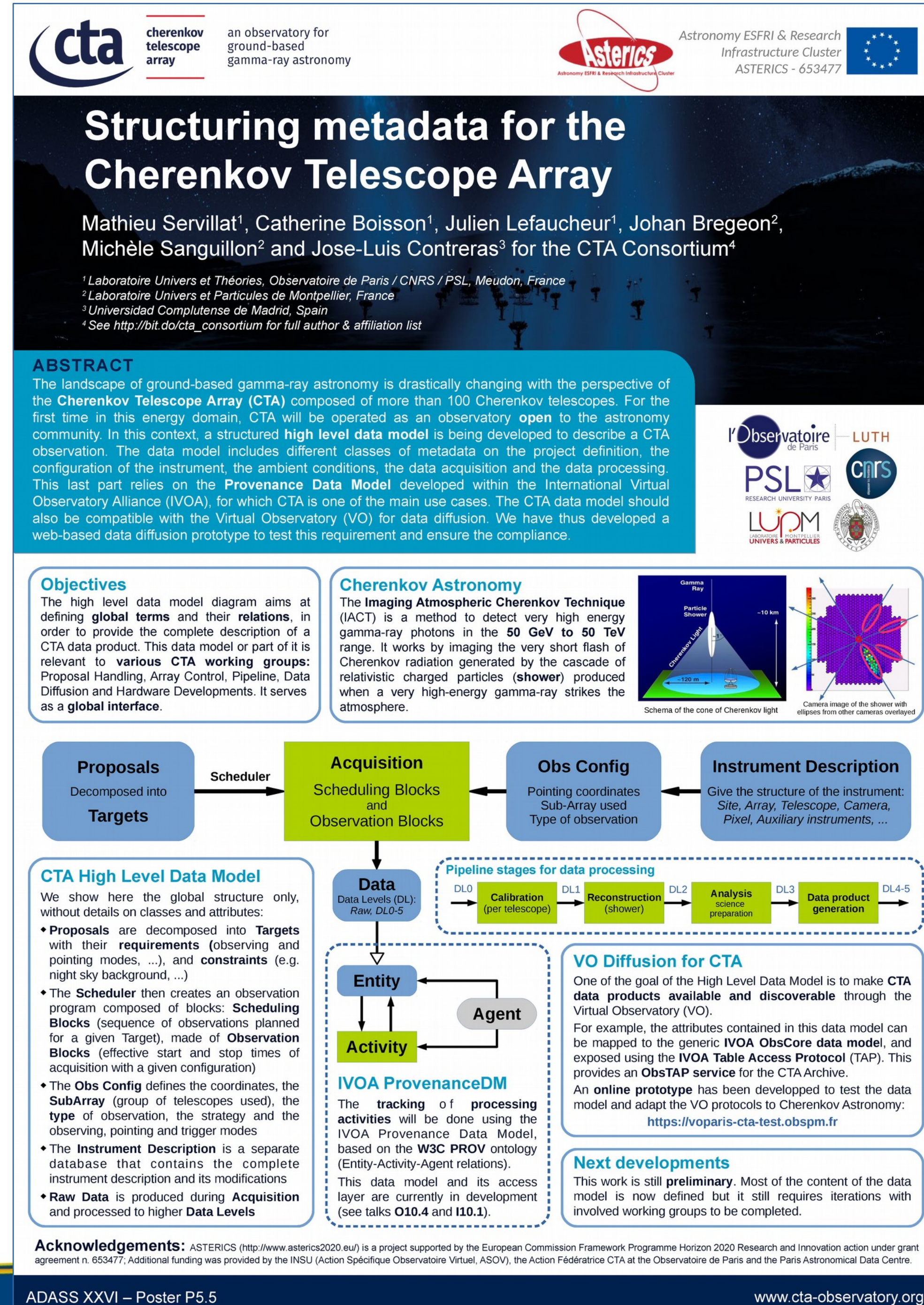


Software engineer: Michèle Sanguillon
Scientists: Ana Palacios, Agnès Lèbre

Use case: CTA

- see Poster by **Mathieu Servillat:**

  P5.5 (upstairs)
- must ensure that data processing can be traced and reproduced
- essential to inform users about proccessing steps



What's your use case?

- Would you benefit from a standardized solution to expose your provenance metadata?

  => contact us!

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- Which metadata would you need most?

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Talk to us and join discussions in IVOA data model working group!