All-Sky Astronomy with HiPS and MOCs

ADASS Tutorial 1

Sébastien Derriere
- and the CDS team !

ADASS XXVIII

Live broadcast on CDS channel

CENTRE DE DONNÉES
ASTRONOMIQUES DE STRASBOURG

Online instructions

- http://cds.unistra.fr/adass2018/

All-sky astronomy with HiPS and MOCs

Tutorial 1 - ADASS XXVIII

Sunday, November 11 2018, 13:00-15:00
Instructor: Sébastien Derriere (CDS).

Introduction

The main goal of this tutorial is to teach participants how to use recent Virtual Observatory standards allowing exploration and querying of all-sky datasets. The Hierarchical Progressive Survey (HiPS) and the Multi-Order Coverage map (MOC) can be used by data providers to expose their datasets (images or catalogues), and astronomers can use them to perform complex queries on all-sky datasets. Participants will create image and catalogue HiPS, learn how to compare them to reference datasets, and share them in a web page. Advanced usage with the Table Access Protocol and astropy/MOCpy will also be shown.

Primary learning objectives:

- How to generate HiPS and MOCs from example datasets, for both image and catalogue data.
- How to visualize all-sky datasets from the full-sky view, down to the original full resolution, and how to share and publish them (for example with Aladin lite).
- How to compare, combine and query large datasets, using CDS tools like Aladin desktop or scripts in Python.

Requirements for participants:

- Personal laptop with at least **1GB of available disk space** for data storage and processing, Wifi or network access.
- Software - you can run the tutorial with Windows, Linux or MAC, provided you have installed:
  - Web browser with JavaScript enabled.
  - Java 7 or higher, and ability to run command-line programs.
  - Aladin Desktop
  - HipsGen-Cat
  - Optionally: Python with Astroquery (astropy) package and MOCpy (for advanced use case 6.2).
- **Please download these data samples before attending the tutorial !** Test images and catalogues (~200MB total – will be available on USB sticks during the tutorial if needed):
  - https://seafile.unistra.fr/d/3713e2d5937747faa595/

Sidebar navigation
Introduction
Plan
1. Generate HiPS image survey and MOC
2. Catalogue HiPS
3. Comparing with other surveys
4. Queries by MOC
5. Publishing with Aladin Lite
6. Adanced usage of HiPS and MOCs
   TAP queries
   Python

Download data samples !

- Hopefully you already did :)
- If not : https://seafile.unistra.fr/d/3713e2d5937747faa595/
- Or ask for a tutor to copy them from USB stick

~200MB data sample

What is HiPS ?

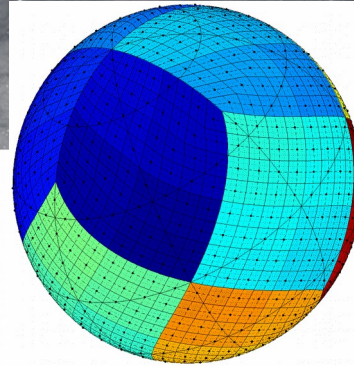- ## Hierachical Progressive Survey
  "The more you zoom in on a particular area, the more details show up"

- Multi-resolution HEALPix data structure
  for Images, Catalogues, 3-dimensional data cubes, …

- Conserves scientific data properties alongside visualisation considerations

- No databases or servers, just HTTP
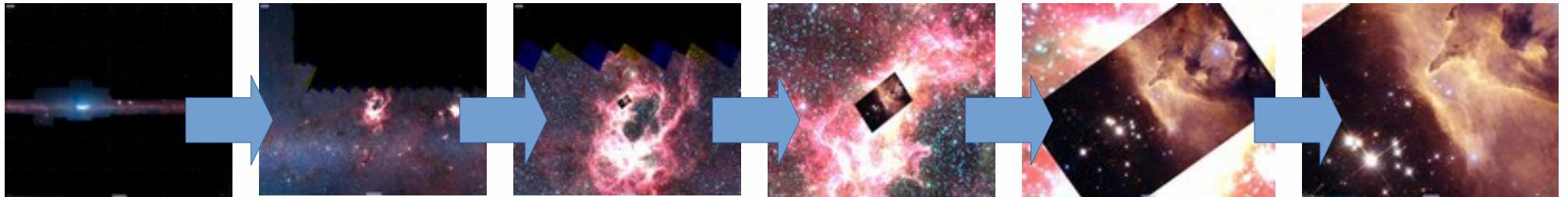
What is HiPS ?

- HEALPix (Gorski et al. 2005)
  - **12 quadrilateral pixels**
  - 2x2 division at each level
  - **Equal area,** Iso-latitude

- HiPS = Mosaic of HEALPix tiles (HEALPix pixel geometry)

HiPS (Halpha Finkbeiner)
order 3 = 768 tiles

HiPS tile number 315
containing 512x512 HEALPix cell values

512

512

Tile 315

Norder3
Dir0
...
Npix315.fits
...
Norder4

HEALPix grid details
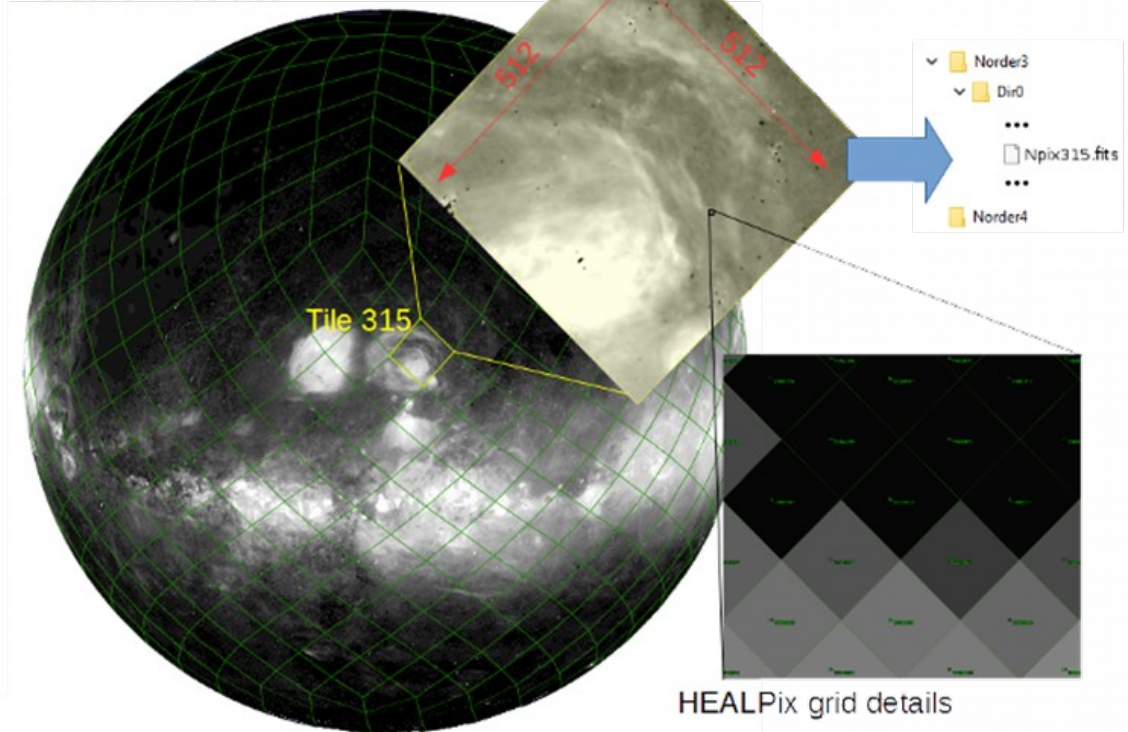
What is HiPS ?

- HiPS = Collection of tiles as files.
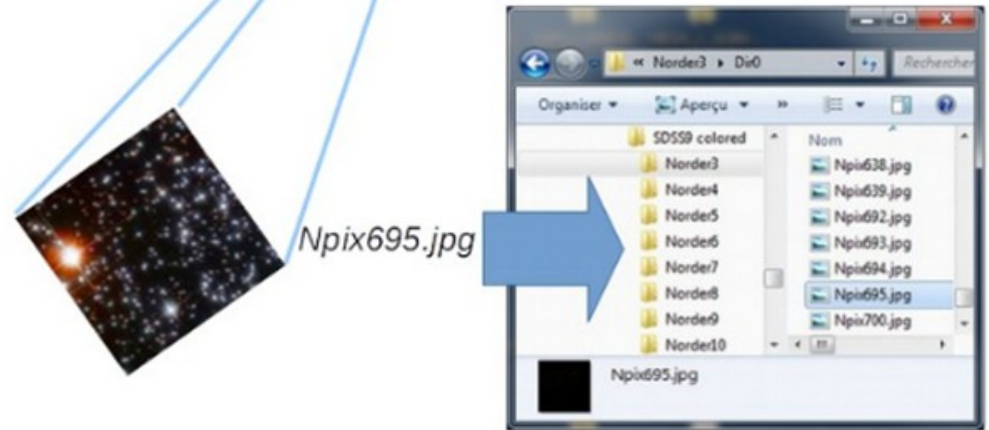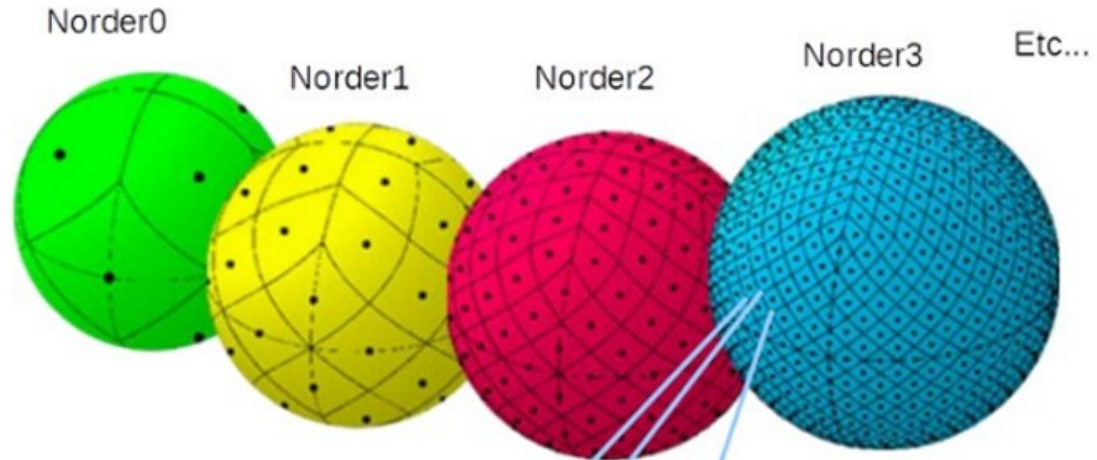
What is MOC ?

- Multi-Order Coverage map
  "Combine sky regions in few milliseconds"

- A simple and efficient method to specify any kind of sky regions

- Based on HEALPix tessellation

- Existing libraries: Java, C, python
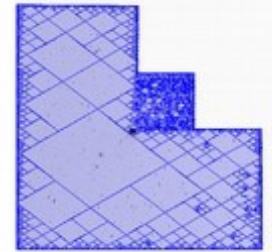
- Used in VO tools (Aladin, TOPcat, ...)

What is MOC ?

- "Just" the list of HEALPix cell numbers covering a region

- 4 adjacent cells are replaced by the parent, recursively → intrinsic compression

- Store as a FITS table (or JSON)

- MOC accuracy depends of the MOC **order**
  = the smallest HEALPix cell level used in the MOC
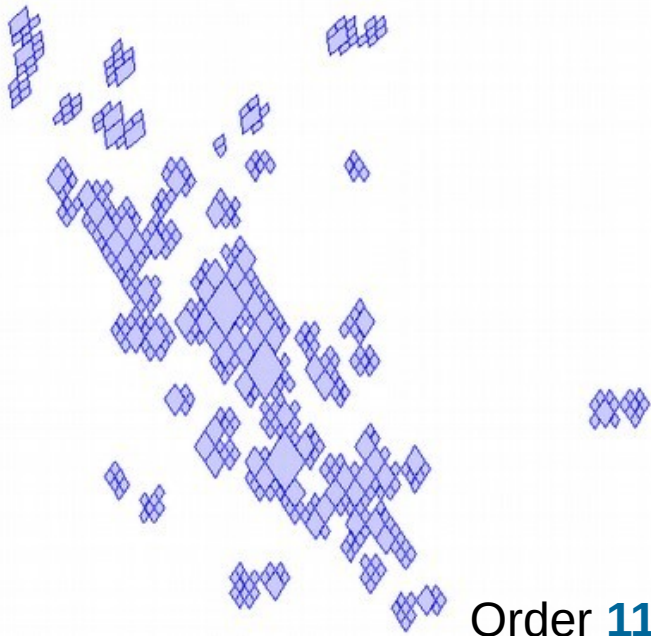
Order **11**
=>1.718 arcsec
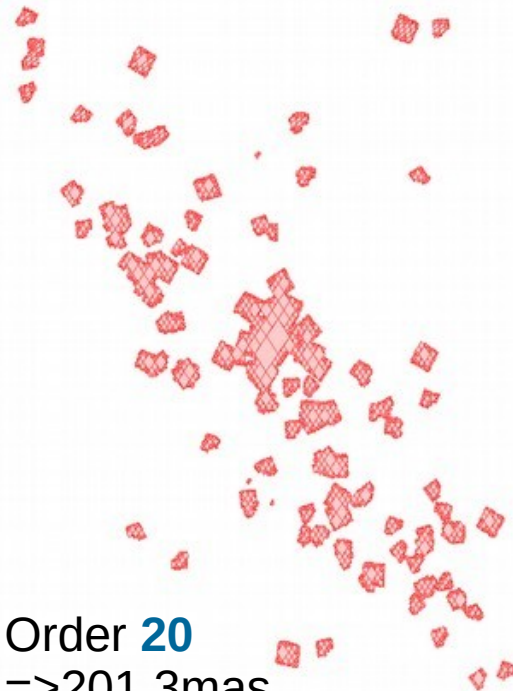
Order **20**
=>201.3mas

Order **29**
=>391 µas

IVOA standards

Program of this tutorial

1. Generate HiPS image survey and MOC

2. Generate catalogue HiPS

3. Comparing with other surveys

4. Queries by MOC

5. Publishing with Aladin Lite

6. Adanced usage of HiPS and MOCs

   – 6.1 TAP queries

   – 6.2 Python

Optional,
if you have time !
Can be done
in any order.

Program

- This is a tutorial : YOU do the work !
- Raise your hand if you have questions, or need support.

☐ That's it !

- We hope you learned new skills

- Try it with YOUR own data

- Thank you for your participation!