

All-Sky Astronomy with HiPS and MOCs

ADASS Tutorial 1

Sébastien Derriere
- and the CDS team !



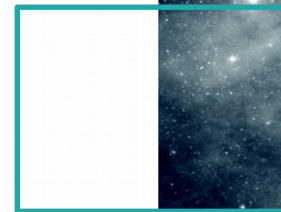
**ADASS
XXVIII**



CENTRE DE DONNÉES
ASTRONOMIQUES DE STRASBOURG



Live broadcast
on CDS channel



Online instructions

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

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. Advanced usage of HiPS and MOCs

TAP queries
Python

All-sky astronomy with HiPS and MOCs

Tutorial 1 - ADASS XXVIII

Sunday, November 11 2018, 13:00-15:00

Instructor: Sébastien Derrière (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/>

□ 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 ?

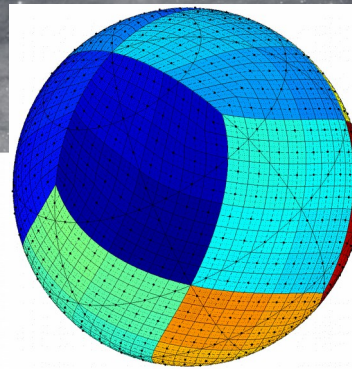
- **Hierarchical Progressive Survey**

"The more you zoom in on a particular area, the more details show up"

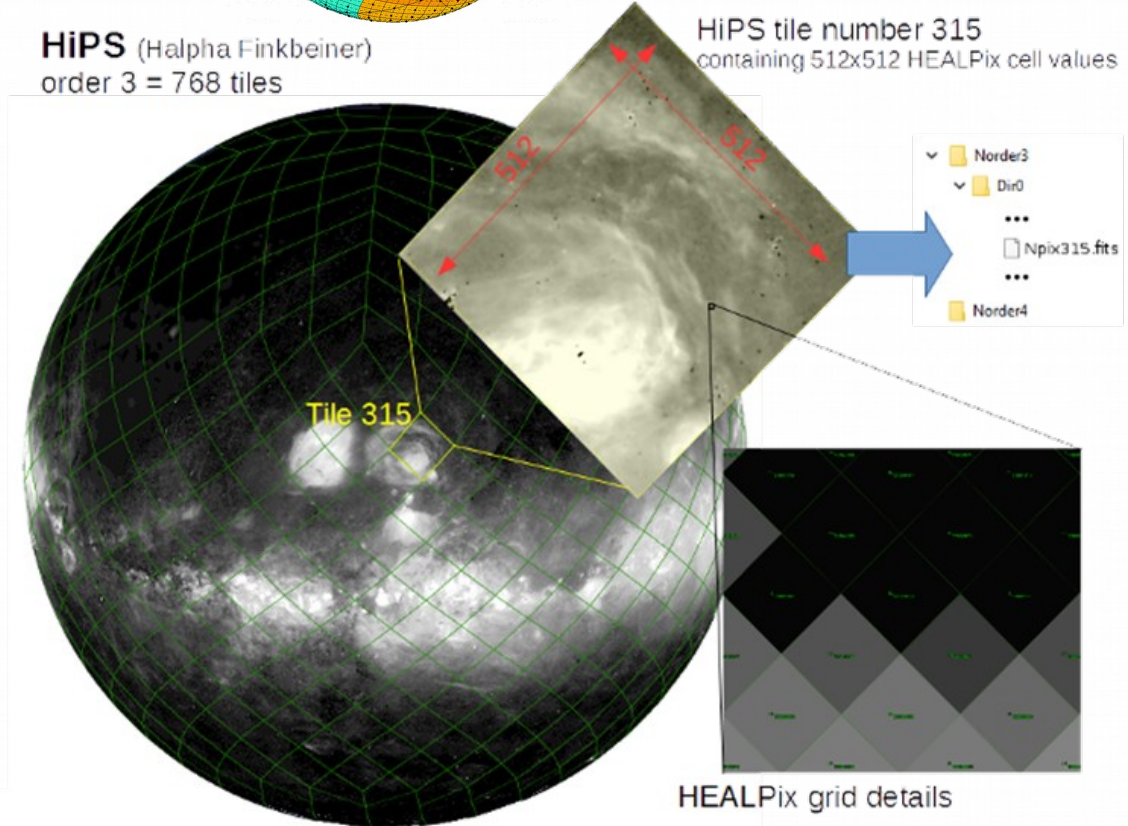
- Multi-resolution **HEALPix** data structure for **Images**, **Catalogues**, 3-dimensional data **cubes**, ...
- Conserves scientific data properties alongside visualisation considerations
- No databases or servers, just HTTP



What is HiPS ?

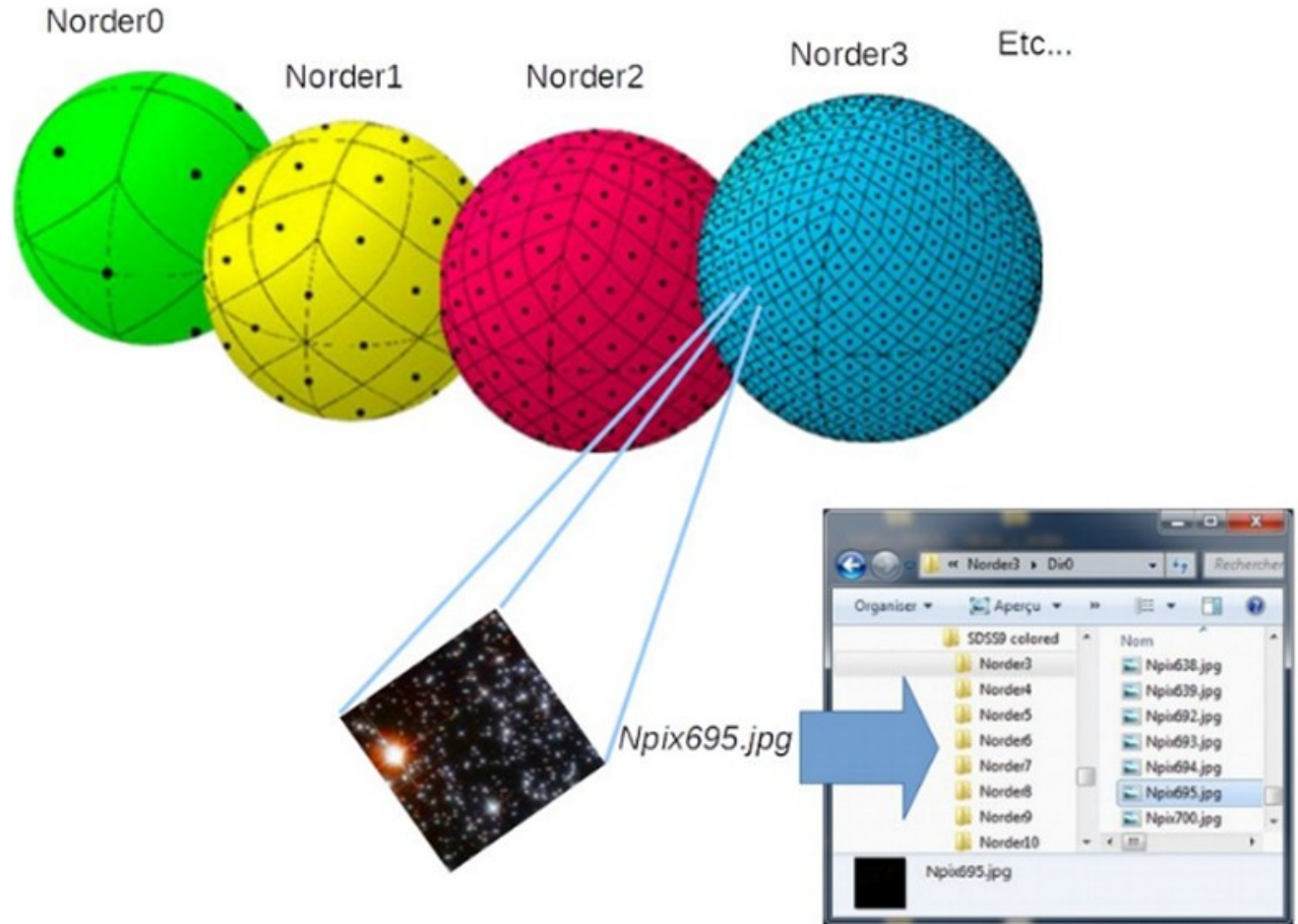


- HEALPix (Gorski et al. 2005)
 - 12 quadrilateral pixels
 - 2x2 division at each level
 - Equal area, Iso-latitude
- HiPS = Mosaic of HEALPix tiles (HEALPix pixel geometry)



□ What is HiPS ?

- HiPS =
Collection of
tiles as files.



□ What is MOC ?

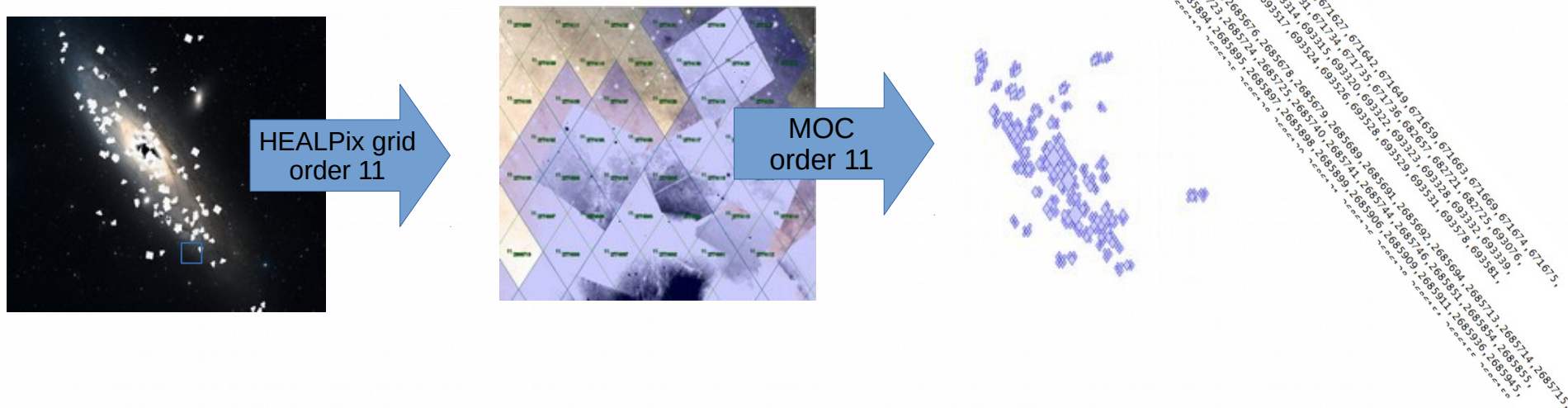
- **Multi-Order Coverage map**

“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 ?

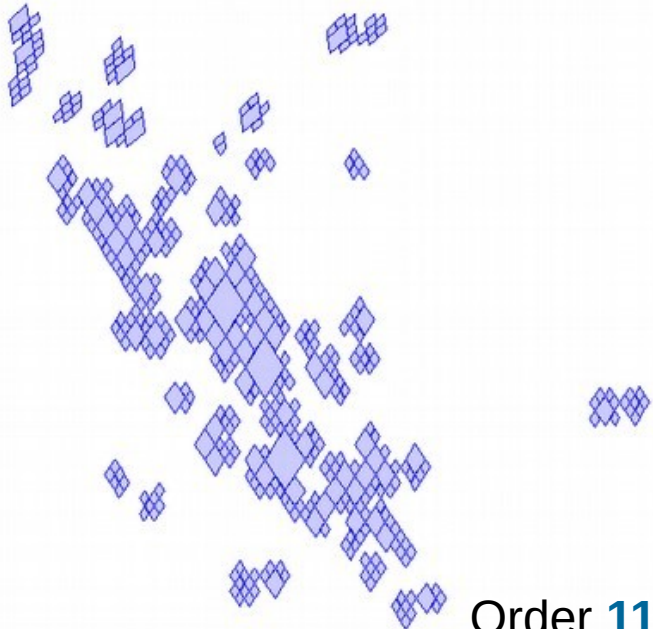
- “Just” the list of HEALPix cell numbers covering a region



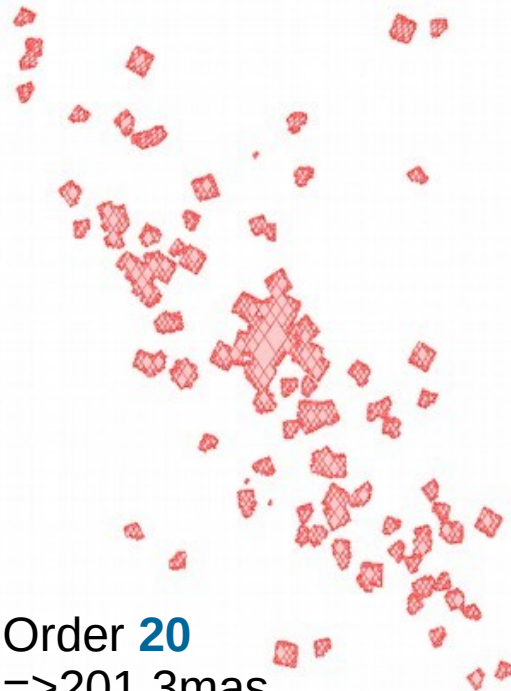
- 4 adjacent cells are replaced by the parent, recursively
→ intrinsic compression
- Store as a FITS table (or JSON)

□ What is MOC ?

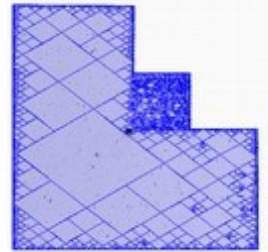
- MOC accuracy depends of the MOC **order**
= the smallest HEALPix cell level used in the MOC



Order **11**
=>1.718 arcsec



Order **20**
=>201.3mas



Order **29**
=>391 μ s

...

□ IVOA standards



HiPS – Hierarchical Progressive Survey

Version 1.0 IVOA Recommendation 19th May 2017

This version:

1.0: Recommendation 2017-05-19

Previous version(s):

1.0: Proposed Recommendation 2017-04-06
1.0: Proposed Recommendation 2017-04-03
1.0: Proposed Recommendation 2017-02-07
1.0: Proposed Recommendation 2016-11-22
1.0: Working Draft 2016-06-23

Interest/Working Group:

Applications: <http://www.ivoa.net/wiki/bin/view/IVOA/IvoaApplications>

Editor:

Pierre Fernique

Authors:

Pierre Fernique, Mark Allen, Thomas Boch, Tom Donaldson, Daniel Durand, Ken Ebisawa, Laurent Michel, Jesus Salgado, Felix Stoehr

Abstract

This document presents HiPS, a hierarchical scheme for the description, storage and access of sky survey data. The system is based on hierarchical tiling of sky regions at finer and finer spatial resolution which facilitates a progressive view of a survey, and supports multi-resolution zooming and



International
Virtual
Observatory
Alliance

MOC – HEALPix Multi-Order Coverage map Version 1.0 IVOA Recommendation 2 June 2014

This version:

1.0: Recommendation 2014-06-02

Previous version(s):

None

Interest/Working Group:

Applications: <http://www.ivoa.net/wiki/bin/view/IVOA/IvoaApplications>

Editor:

Pierre Fernique

Authors:

Thomas Boch, Tom Donaldson, Daniel Durand, Pierre Fernique, Wil O'Mulane, Martin Reincke, Mark Taylor

Abstract

This document describes the Multi-Order Coverage map method (MOC) to specify arbitrary sky regions. The goal is to be able to provide a very fast comparison mechanism between coverage maps. The mechanism is based on the HEALPix sky tessellation algorithm. It is essentially a simple way to map regions of the sky into hierarchically grouped predefined cells.

□ 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. **Advanced 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!