Exploring catalogue with **CatTiler**

On-demand generation of HiPS density tiles using TAP queries

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and the CDS team

IVOA Interop, Paris, Apps: HiPS

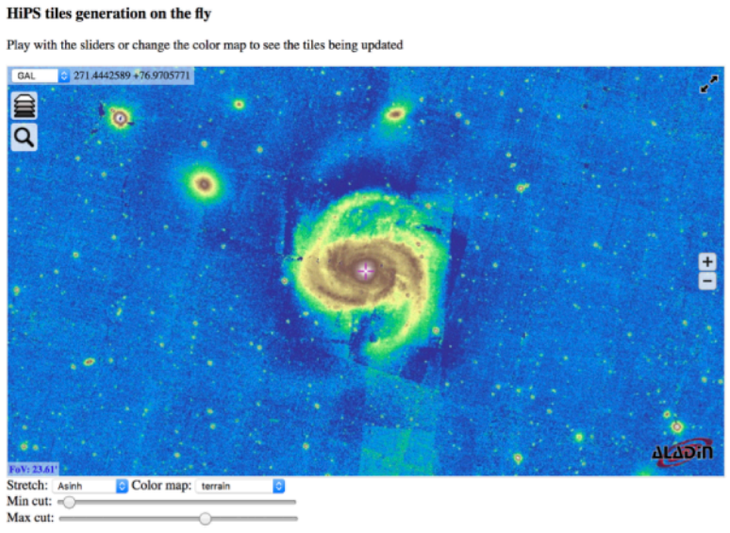
CENTRE DE DONNÉES ASTRONOMIQUES DE STRASBOURG

Previously…

IVOA College Park

On the fly generation of HiPS JPEG tiles

- aladin.unistra.fr/AladinLite/showcase/dynamic-tiles-generation/



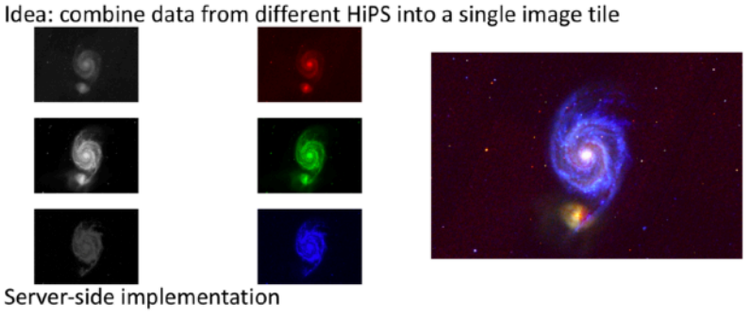
IVOA College Park - Nov 2018 - Generation of JPEG HiPS tiles - Apps2

in production

HiPS color mixer

HiPS tiles mixing service

- Idea: combine data from different HiPS into a single image tile



- Server-side implementation
  - no support for FITS tiles in Aladin Lite (yet)
  - extending the service previously shown
  - alternative: client-side mixing
- Prototype demo

prototype

Spatial exploration of catalogues

Plot the sky positions of (large) catalogue sources matching some criteria … in an interactive manner

- Issues
  - overplotting
  - transfer time and memory for large catalogues
    - *eg* Gaia DR2 positions for sources in LMC
      23 million sources
      360 MB data for RA+Dec

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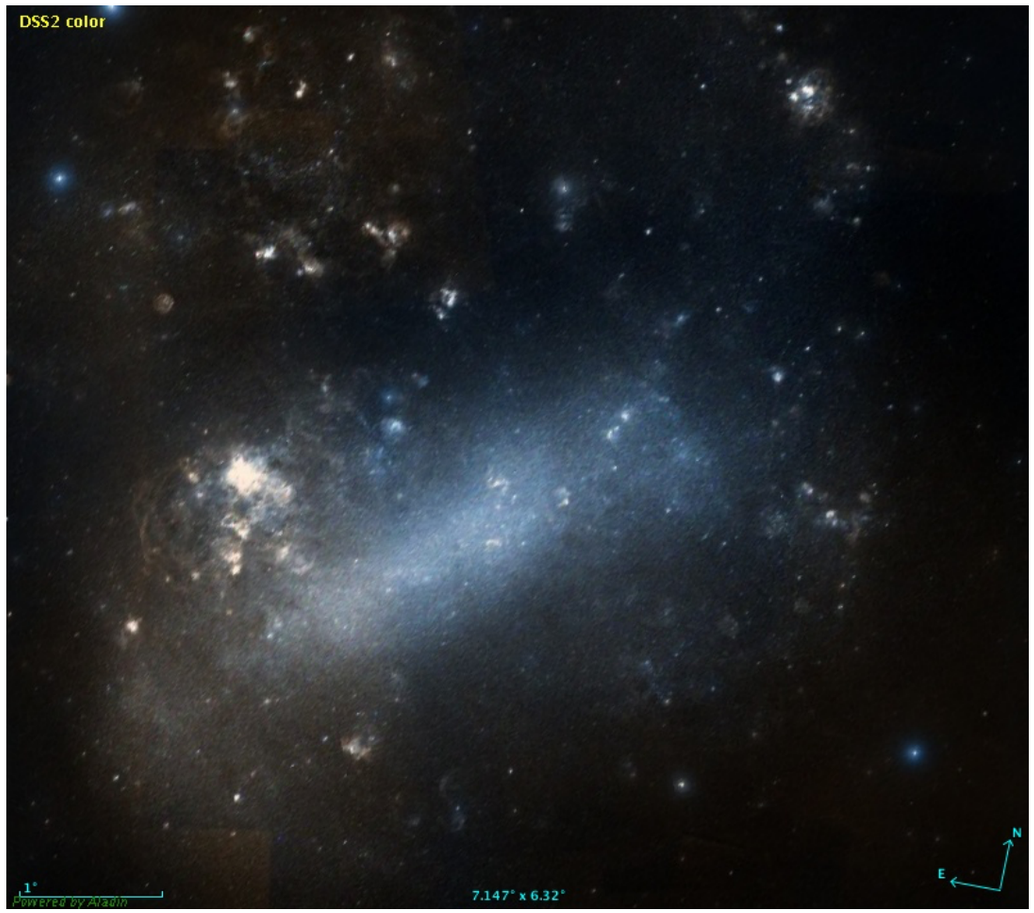

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Density maps to the rescue

- Project each source on a tessellation of the sphere
  - *eg* HEALPix
- Aggregate
  - count
  - weight by a given column value

- ADASS 2016 poster
  All of the Sky: HEALPix Density Maps of Gaia-scale Datasets from the Database to the Desktop,
  Taylor et. al

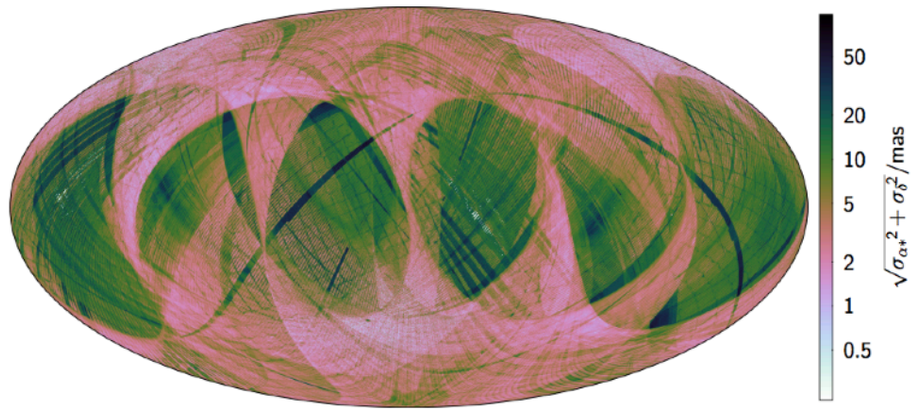


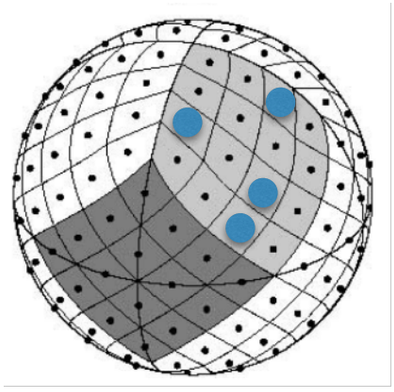
Figure 2. Mean isotropic positional error of Gaia DR1 sky positions, using the query: "`SELECT source_id/2199023255552 AS hpx9, AVG(SQRT(ra_error*ra_error+dec_error*dec_error)) AS pos_error FROM gaia.dr1 GROUP BY hpx9`". The HEALPix index is recovered from the Gaia `source_id` column using integer division. This query took 70 minutes to scan 1.1 billion rows using the GAVO DC TAP service. Plot by STILTS.

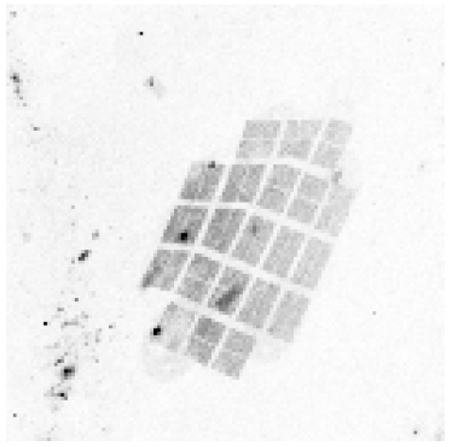
CatTiler

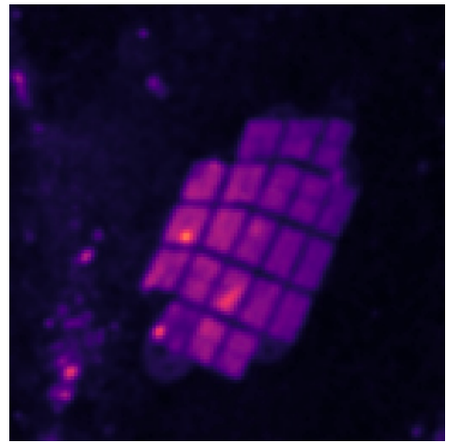
Build HiPS density tiles from a TAP query,
using HEALPix User-Defined Function

Data retrieval → Projection → Aggregation → Transformation
(color map, min/max cut, stretch, gaussian kernel, etc)

ra	ra_error	dec
282,2384	0,3465	-31,47409
282,24061	0,6458	-31,47358
282,23724	1,5003	-31,47245
282,23664	2,0052	-31,47092
282,23475	1,0451	-31,47134
282,23563	0,5777	-31,47031
282,23726	0,7896	-31,46885
282,24034	1,2116	-31,46636
282,23795	0,285	-31,46605
282,24533	0,2395	-31,46741
282,24594	0,437	-31,46765
282,2443	8,7268	-31,46725
282,24681	1,1339	-31,46677
282,24727	0,7675	-31,46573
282,24775	0,4944	-31,46385
282,24111	15,7594	-31,46617
282,24359	0,2863	-31,46496
282,24266	21,5014	-31,46394







TAP query

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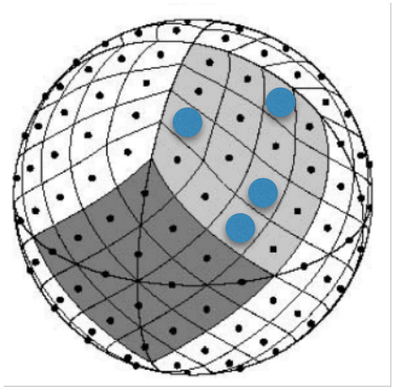

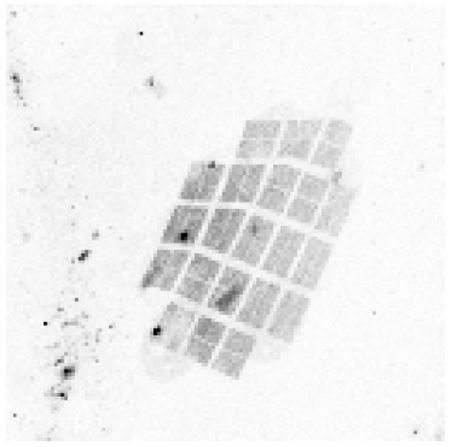

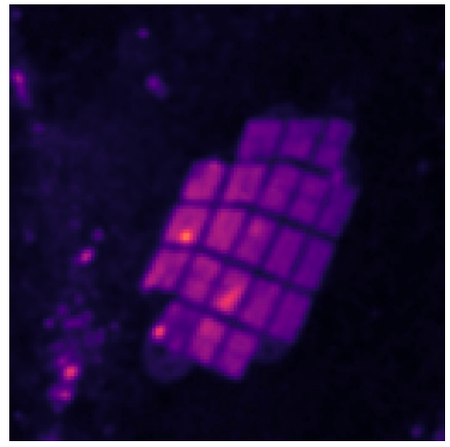

CatTiler service

- more flexible than building the whole map in one-go
  - can go deeper
  - creates only tiles of the region currently displayed

- example query to generate 128x128 pixels tile #528 at order 3:

```
SELECT HEALPIX(RAJ2000, DEJ2000, 10) AS ipix, COUNT(*) as cnt
FROM "II/246/out"
WHERE HEALPIX(RAJ2000, DEJ2000, 3)=528  GROUP BY ipix
```

- parameters
  - tap_service
  - tap_request_select
  - tap_request_from
  - tap_request_where
  - tile_size
  - cmap, stretch, min/max_cut

- Python-powered Falcon service
  - *pyvo*
  - *cds-healpix*
  - *astropy* for tile image stretching and normalization

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```
https://alasky.u-strasbg.fr/cat-tiler/Norder3/Dir0/Npix528.jpg?
tap_service=http%3A%2F%2Ftapvizier.u-strasbg.fr%2FTAPVizieR%2Ftap&
tap_request_select=COUNT(*)&
tap_request_from=%22II%2F246%2Fout%22&
tap_request_where=&
tile_size=128&cmap=viridis&min_cut=0&max_cut=46.5625&stretch=asinh&mod
e=single&
```

- Python-powered Falcon service
  - *pyvo*
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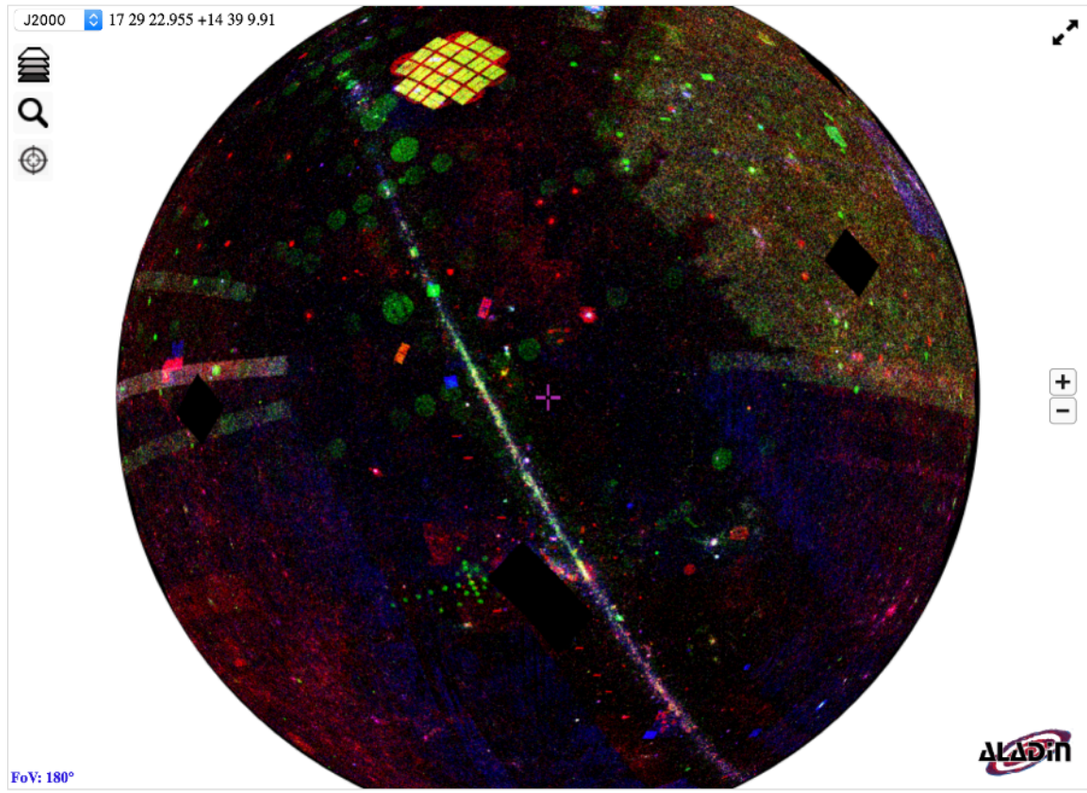
Tests

- VizieR
  - UDF `HEALPIX(ra, dec, order)`
- Simbad
  - no HEALPix UDF, *hpx* field in table BASIC
  - limited to HEALPix order 10
- GAVO DC TAP
  - UDF `ivo_healpix_index(order, ra, dec)`
- Heidelberg Gaia TAP
  - UDF `ivo_healpix_index(order, ra, dec)`

Demo

- Density map of objects cited in A&A papers
- Glade catalogue
- 2MASS



Comments

- Heavy queries: is this an abusive use of TAP services?
- Would be nice to standardize the UDF name

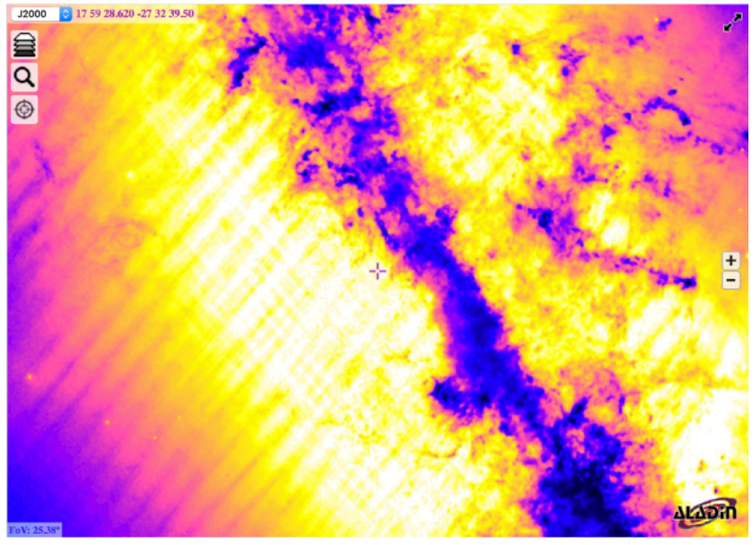
Make it faster

- convert Gaia DR2 catalogue data to *column-based* format
  - HDF5 (colfits could be also used)
  - query column-based files with *vaex* (python library to visualize and explore large tabular datasets)

- translate TAP queries to vaex (numpy) constraints

- Benefits
  - only columns needed by the query

- Demo



Future plans

- Generate FITS tiles
  - would allow for better interactivity when changing min/max cuts
  - support FITS tiles in Aladin Lite

Updates to HiPS standard

- Support of parameterized HiPS URL requires updates to HiPS document
- How to describe parameters?
  - *properties* file
  - For each parameter
    - name
    - description
    - type
    - required/optional
    - range of allowed values

- which syntax?
  - HiPS *properties* is a **key = value** text file