POMME

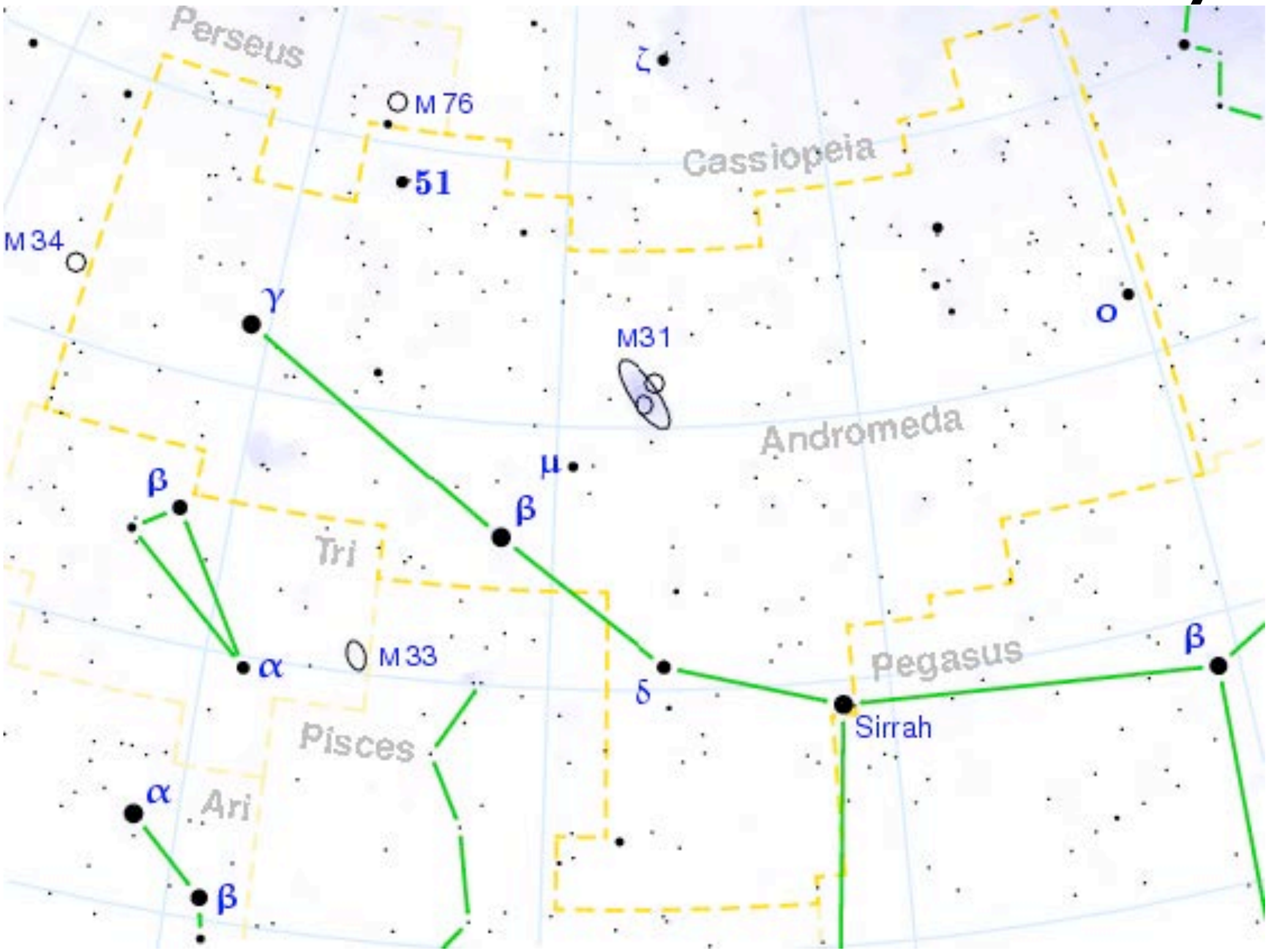
Pixel Observations of M31 with MEgacam

Utilisation de TAP pour les courbes de lumière et client Web associé avec micro traitement en ligne

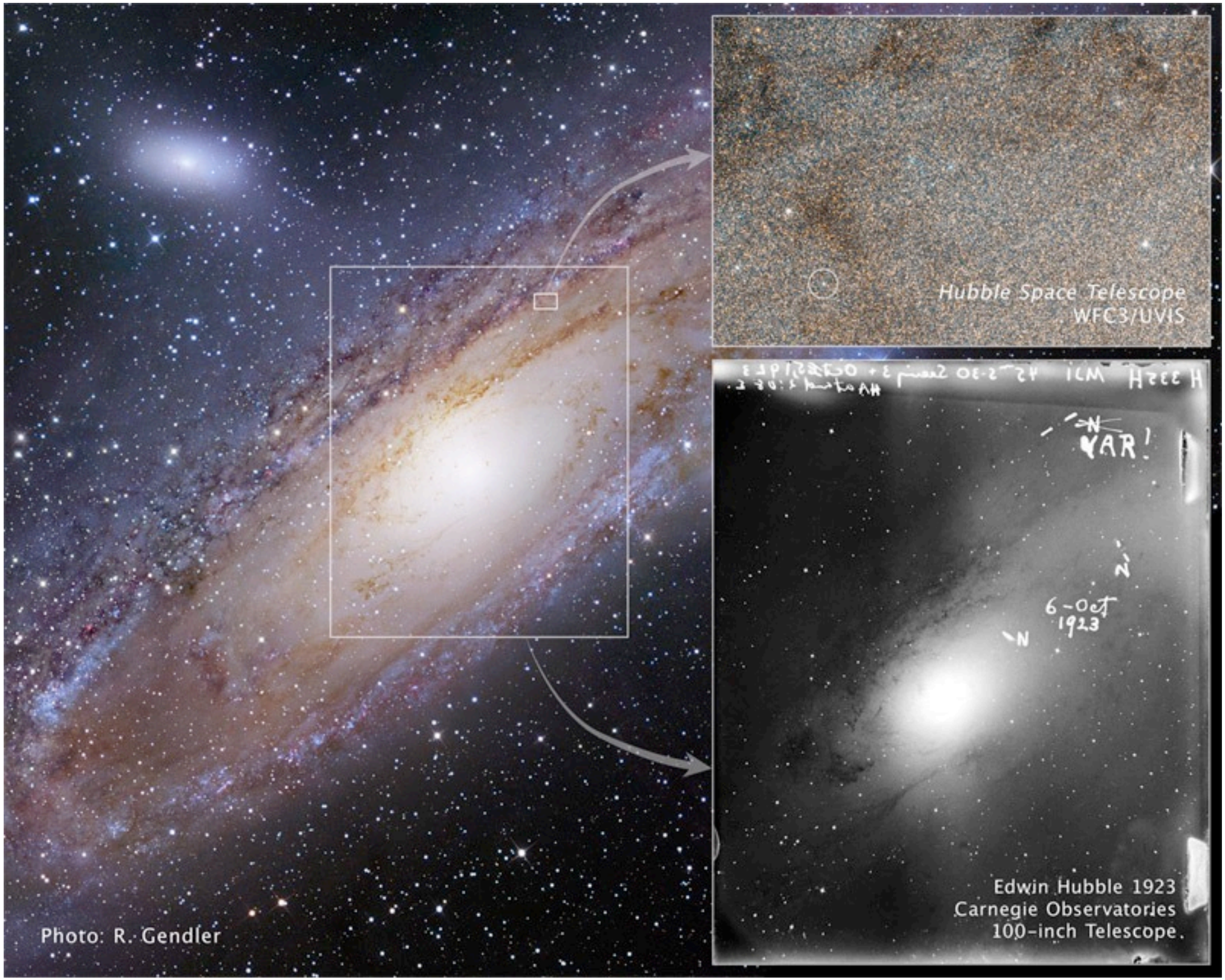
Renaud Savalle (Obs Paris/VOPDC) and the POMME collaboration

Journée ASOV consacrée à la publication des données dans l'OV et au protocole IVOA TAP
Observatoire de Paris
17 septembre 2014

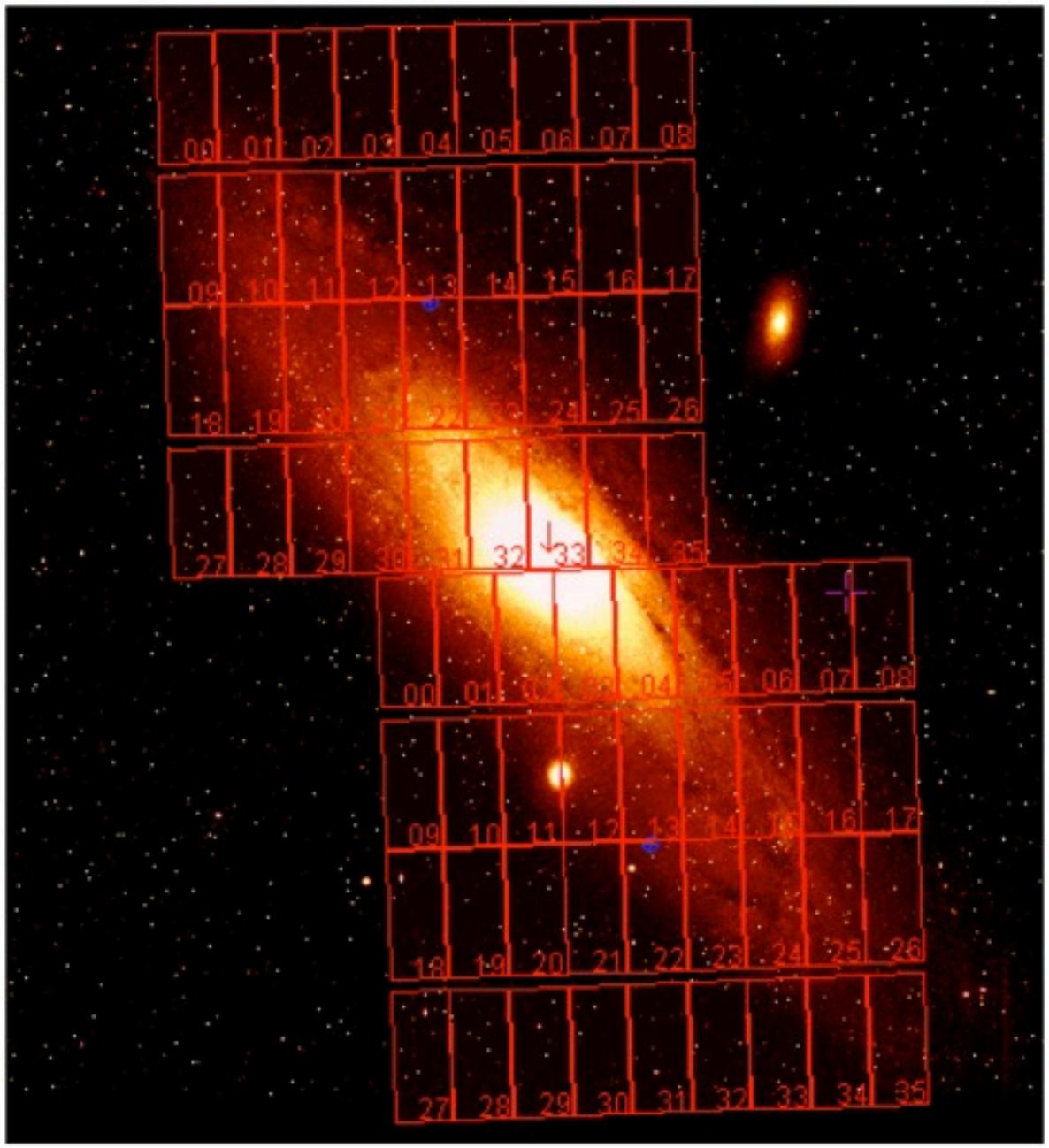
M31 - The Andromeda Galaxy



The first Cepheid in M31



POMME - Pixel Observations of M31 with MEgacam

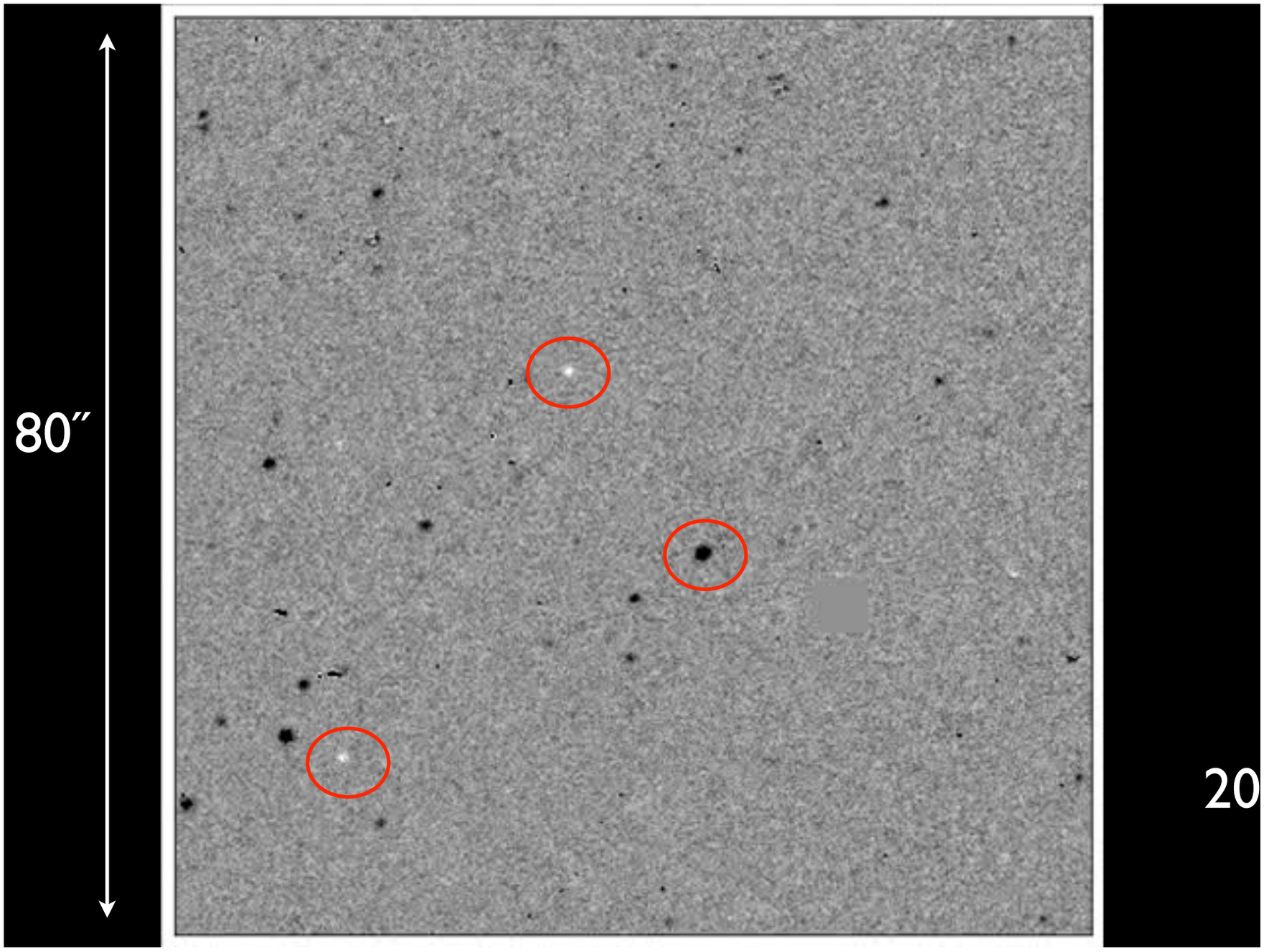


- 2 epochs:
  - 2004/08-10
  - 2005/08-10
- **2 fields Megacam@CFHT**
- 3 filters: g',r',i'

- Median seeing: **0.7 arcsecs**

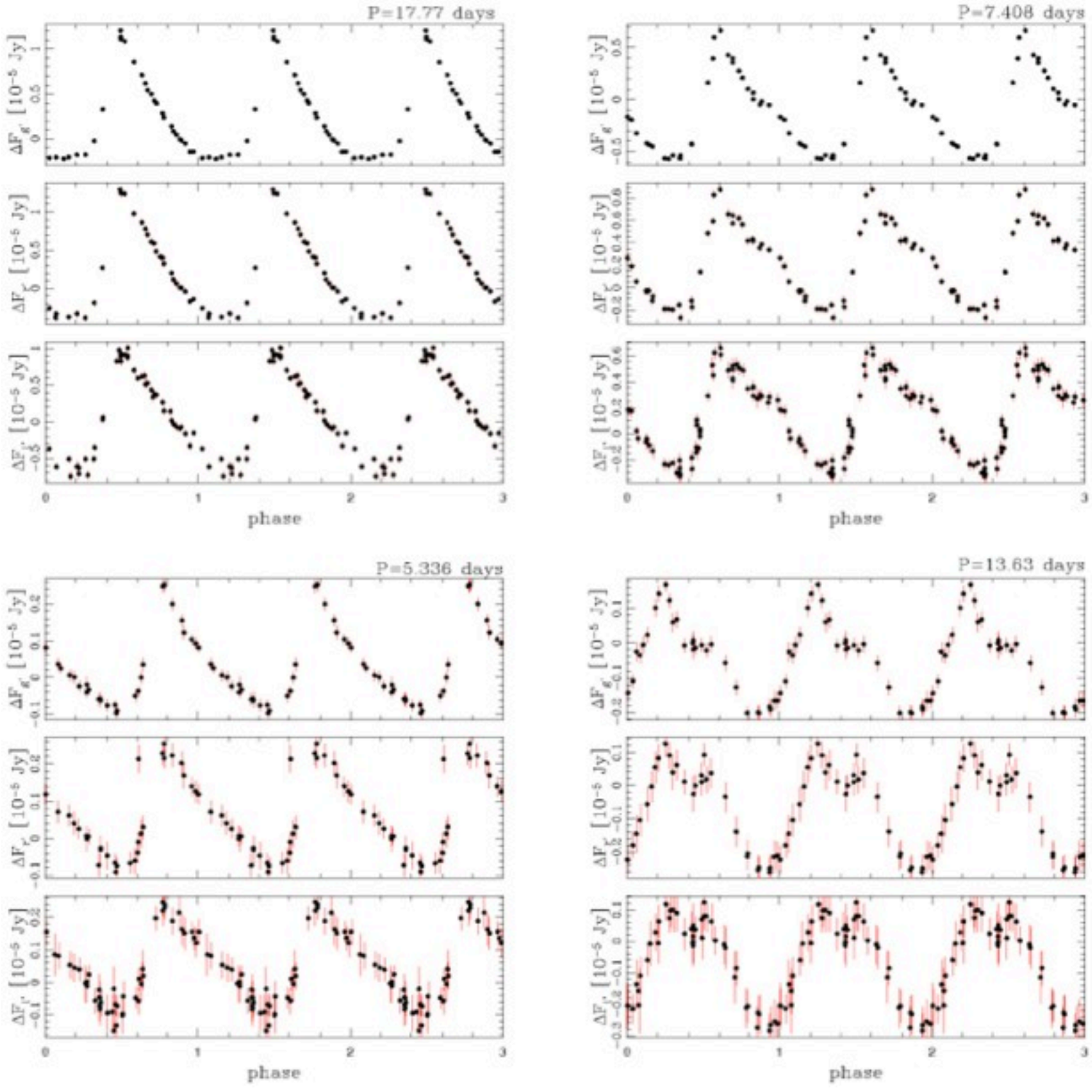
- Science goals: **time-domain**
  - Identify variables
  - Determine their types
  - Study cepheids and EBs
  - Improve distance determination

Difference Imaging Analysis



$$Var(x,y,t) = Image(x,y,t) - Reference(x,y) \otimes PSF(x,y,t)$$

POMME Light curves



The PostgreSQL POMME DB

- Main catalogs: Positions, light-curves, sources

variables

id	CHARACTER VARYING(12)
ra	CHARACTER VARYING(12)
de	CHARACTER VARYING(12)
period	DOUBLE PRECISION
num	INTEGER

65,400 rows

lightcurves

variable_id	CHARACTER VARYING(12)
band	CHARACTER(1)
mjd	DOUBLE PRECISION
dflux_a	DOUBLE PRECISION
dflux_psf	DOUBLE PRECISION
err_dflux_a	DOUBLE PRECISION
err_dflux_psf	DOUBLE PRECISION

8,287,978 rows

sources

ipp_idet	BIGINT
x_psf	REAL
y_psf	REAL
x_psf_sig	REAL
y_psf_sig	REAL
posangle	REAL
pltscale	REAL
psf_inst_mag	REAL
psf_inst_mag_sig	REAL
psf_inst_flux	REAL
psf_inst_flux_sig	REAL
ap_mag	REAL

8,215,485 rows

- Cross-matches: examples: SIMBAD, VizieR

x_2_simbad_variables_all

id_1	CHARACTER VARYING(11)
ra_1	CHARACTER VARYING(12)
de_1	CHARACTER VARYING(12)
period	REAL
ra_2	DOUBLE PRECISION
de_2	DOUBLE PRECISION
id_2	CHARACTER VARYING(32)
V__vartyp	CHARACTER VARYING(6)
V__LoVmax	CHARACTER(1)
V__Vmax	REAL
V__B_Vmax	CHARACTER(1)

x_2_j_a_a_459_321_table3

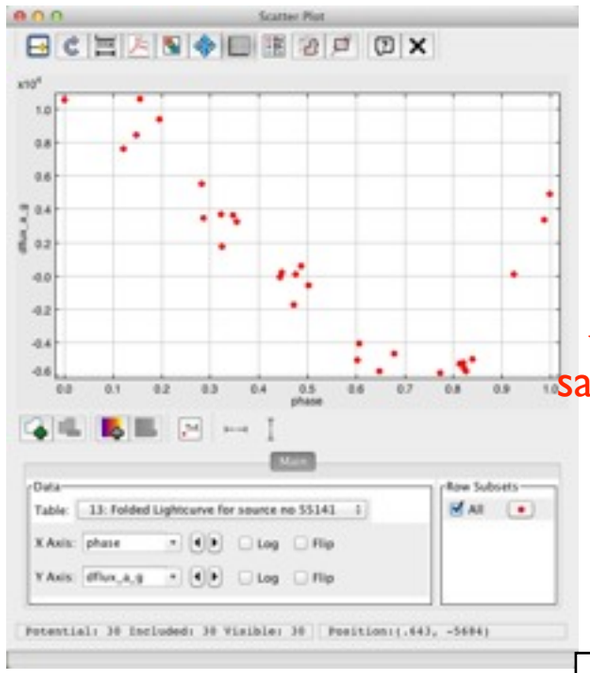
d_arcsec	DOUBLE PRECISION
_RAJ2000	DOUBLE PRECISION
_DEJ2000	DOUBLE PRECISION
Name	CHARACTER VARYING(22)
RAJ2000	DOUBLE PRECISION
DEJ2000	DOUBLE PRECISION
Vmag	REAL
e_Vmag	REAL
Bmag	REAL
e_Bmag	REAL

x_2_j_a_a

- Indices

Architecture of first demonstrator

TOPCAT



Web Browser

samp.js

Web Page

Pomme Applet

VOT

tmp VOT files

ADQL/VOT

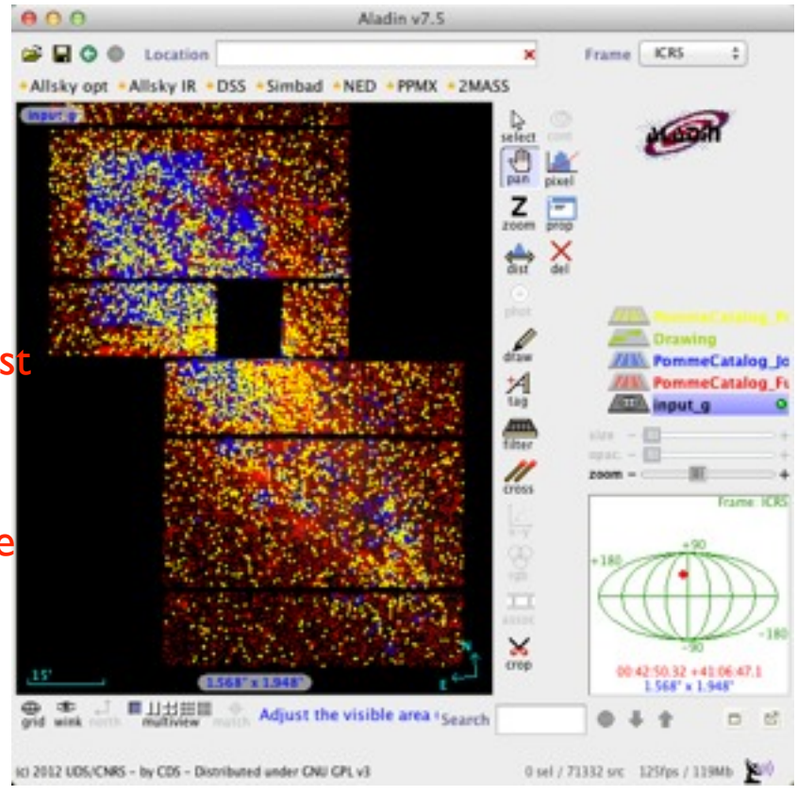
samp.load.fits

samp.load.votable

table.select.rowList

samp.load.votable

Aladin



HTTP

APACHE HTTP SERVER

Pomme DB

SQL

DaCHS TAP Server

q.rd

Architecture of new demonstrator

APACHE HTTP SERVER

Apache Tomcat

POMME Servlet

Savot.java

HTTP

HTTP Post

CSV/JSON

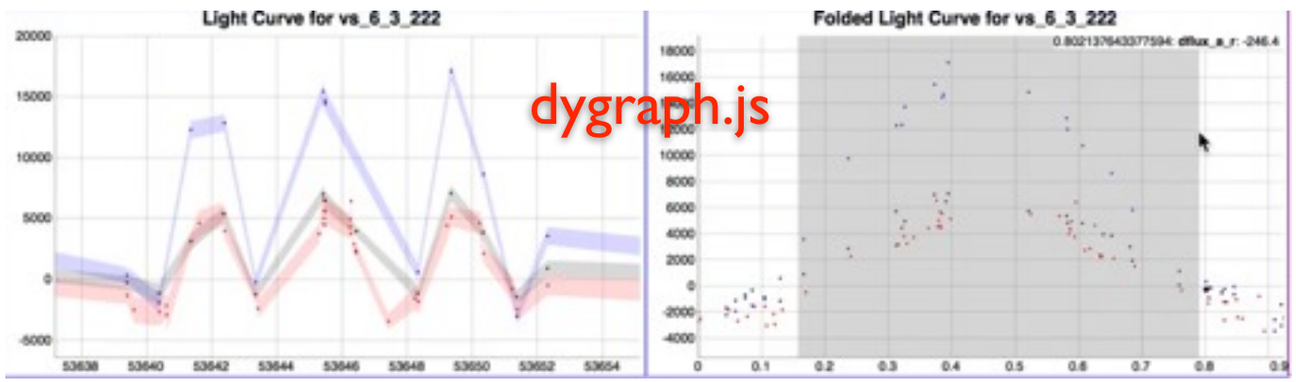
TAP/ADQL

VOT

Web Browser

jquery.js

Query Selector



q.rd

DaCHS TAP Server

SQL

POMME DB

The q.rd file (1)

```
<?xml version="1.0" encoding="iso-8859-1"?>

<resource schema="pomme">
  <meta name="title">POMME</meta>
  <meta name="creationDate">2012-08-01T17:00:00Z</meta>
  <meta name="description" format="plain">fill in
  </meta>
  <meta name="copyright">POMME</meta>
  <meta name="creator.name">Renaud Savalle</meta>
  <meta name="subject">m31 variables</meta>


<table id="sources" onDisk="True" adql="True">
...
</table>
<table id="variables" onDisk="True" adql="True">
...
</table>
<table id="lightcurves" onDisk="True" adql="True">
...
</table>
<table id="x_2_simbad_variables_all" onDisk="True" adql="True">
...
</table>
...

<data id="import">
   <make table="sources"/>
   <make table="variables"/>
   <make table="lightcurves"/>
   <make table="x_2_simbad_variables_all"/>
   ...
</data>

<data id="collection" auto="false">
   <register services="__system__/tap#run"/>
   <make table="sources"/>
   <make table="variables"/>
   <make table="lightcurves"/>
   <make table="x_2_simbad_variables_all"/>
   ...
</data>
</resource>
```

The q.rd file (2) - table “variables”

```
<table id="variables" onDisk="True" adql="True">
    <meta name="description">POMME Variable stars in M31 (new catalog 20130717)</meta>
    <meta name="referenceURL">TBD</meta>

    <column name="id" type="text" ucd="meta.id;meta.main"
            description="id of the variable star"/>
    <column name="ra" type="text" ucd="pos.eq.ra;meta.main"
            description="right ascension in hh:mm:ss.sss (J2000)"/>
    <column name="de" type="text" ucd="pos.eq.dec;meta.main"
            description="declination in +dd:mm:ss.ss (J2000)"/>
    <column name="period" type="real" ucd="time.period"
            description="period" />
    <column name="num" type="integer" ucd="meta.number" required="True"
            description="number in the catalog" />
    <column name="ra_deg" type="double precision" ucd="pos.eq.ra"
            description="right ascension in decimal degrees (J2000)"/>
    <column name="de_deg" type="double precision" ucd="pos.eq.dec"
            description="declination in decimal degrees (J2000)"/>
</table>
```

The q.rd file (3) - table “lightcurves”

```
<table id="lightcurves" onDisk="True" adql="True">
    <meta name="description">POMME Lightcurves of variable stars in M31</meta>
    <meta name="referenceURL">TBD</meta>

    <column name="variable_id" type="text" ucd="meta.id;meta.main"
        description="id of the variable star"/>
    <column name="band" type="text" ucd="meta.code;instr.filter"
        description="name of filter" />
    <column name="mjd" type="double precision" ucd="time.epoch" unit="mjd"
        description="MJD of observation" />
    <column name="dflux_a" type="double precision" ucd="phot.flux"
        description="Aperture flux difference" />
    <column name="dflux_psf" type="double precision" ucd="phot.flux"
        description="PSF flux difference" />
    <column name="err_dflux_a" type="double precision" ucd="stat.error;phot.flux"
        description="Error on aperture flux difference" />
    <column name="err_dflux_psf" type="double precision" ucd="stat.error;phot.flux"
        description="Error on PSF flux difference" />
</table>
```

```java
/**
     * Create a catalog for Aladin(Lite) from a TAP query and save it in a local file
     * @param tapServer - TAP server to use: POMME, SIMBAD
     * @param tapQuery - ADQL query
     * @param votCatalogFilename - filename to save the result VOTable
     * @return "ERROR" (+string describing the error), or "OK"
     */
    public String getCatalogIntoVOT(final String tapServer, final String tapQuery, final String
votCatalogFilename) {

        System.out.println("PommeServlet.getCatalogIntoVOT: tapServer="+tapServer);
        System.out.println("PommeServlet.getCatalogIntoVOT: tapQuery="+tapQuery);

        // url depends on TAP SERVER to use

        String url = null;
        if(tapServer.equals("POMME")) {
            url = tapUrlPOMME;
        } else if (tapServer.equals("SIMBAD")) {
            url = tapUrlSIMBAD;
        } else {
            System.err.println("PommeServlet.getCatalogIntoVOT: ERROR: UNKNOWN TAP SERVER "+tapServer);
            return "ERROR";
        }

        // TAP Query
        String query=tapQuery;

        // We use a LinkedHasMap which preserves the order of the inserted elements
        LinkedHashMap<String,String> params = new LinkedHashMap<String, String>();

        params.put("REQUEST","doQuery");
        params.put("LANG","ADQL-2.0");
        //params.put("FORMAT","csv");      // retrieve the data in csv format

        // NB: MAXREC=... and FORMAT=votable/td are not understood by SIMBAD TAP server !! 2014-04-24
        if(tapServer.equals("POMME")) {
            params.put("FORMAT","votable/td");// retrieve the data in VOT format, TABLEDATA
            params.put("MAXREC", "100000");        // retrieve more than the 2000 limit
        }

        params.put("QUERY",query);
```

```
        try {

            // POST the query to TAP
            HttpPostResult result = httpPost(url,params);

            if(result.getResult().equals("OK")) { // POST query was OK

                final ArrayList<String> lines = result.getLines(); // final to be accessed in inner class
later
                int lines_length=lines.size();
                System.out.println("PommeServlet.getCatalogIntoVOT: Received "+lines_length+" lines of data
in VOT format.");

                // Create a VOTable from the data
                System.out.println("PommeServlet.getCatalogIntoVOT: Saving VOT into "+votCatalogFilename);

                FileWriter votstream=new FileWriter(votCatalogFilename);
                BufferedWriter vot=new BufferedWriter(votstream);

                for(int l=0;l<lines.size();l++) {
                    vot.write((String)lines.get(l));
                }
                vot.close();
            }


            return result.getResult();


        } catch (Exception e) {
            System.out.println("PommeServlet.getCatalogIntoVOT: Got exception during httpPost or following
processing: ");
            System.out.println("PommeServlet.getCatalogIntoVOT: Exception:"+e.toString());
            System.out.println("PommeServlet.getCatalogIntoVOT: Exception message:"+e.getMessage());
            System.out.println("PommeServlet.getCatalogIntoVOT: Stack:");
            e.printStackTrace();

            return e.toString();
        }

    }
```

Demo

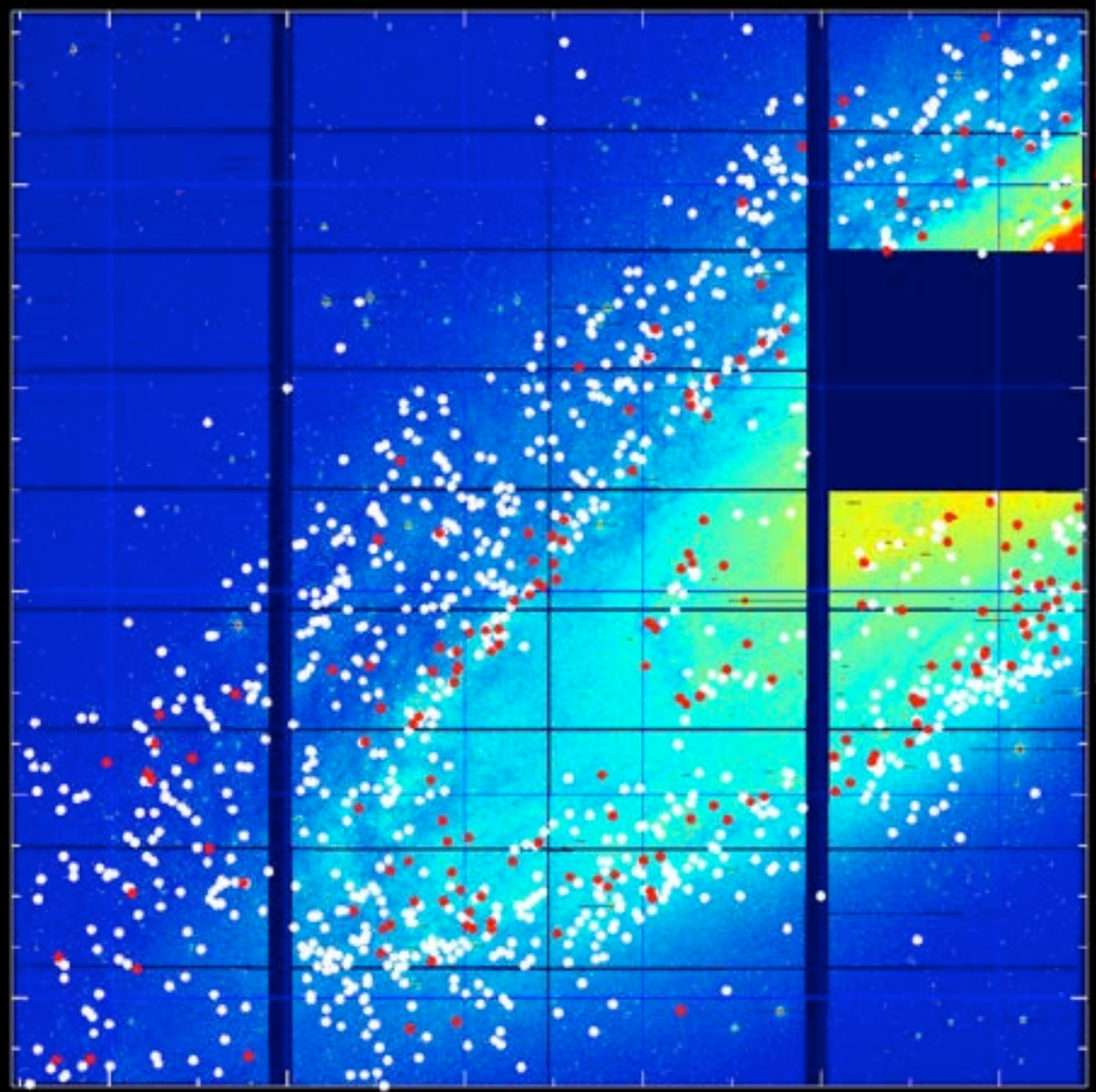
Acknowledgments

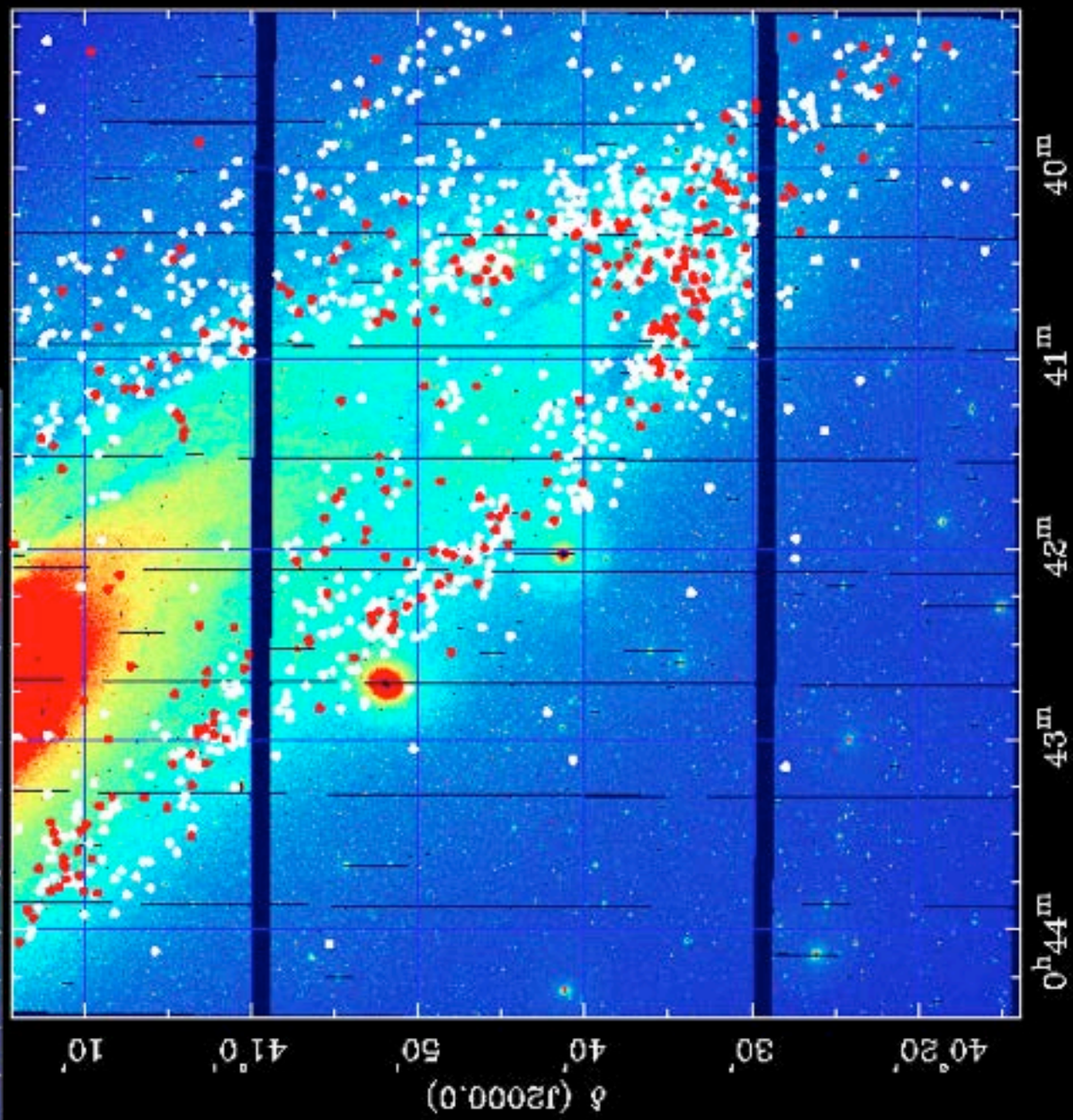
- GAVO **DaCHS** Software Distribution http://soft.g-vo.org/dachs (M. Demleitner)
- **Aladin 8** HEALPIX Generator (2000A&AS..143...33B) (P. Fernique et al)
- **AladinLite** (T.Boch) http://aladin.u-strasbg.fr/AladinLite/
- This research made use of the **cross-match service** provided by CDS, Strasbourg. http://cdsxmatch.u-strasbg.fr/xmatch
- This research has made use of the **SIMBAD** database, operated at CDS, Strasbourg, France
- **dygraphs** is a fast, flexible open source JavaScript charting library. http://dygraphs.com/

Questions ?

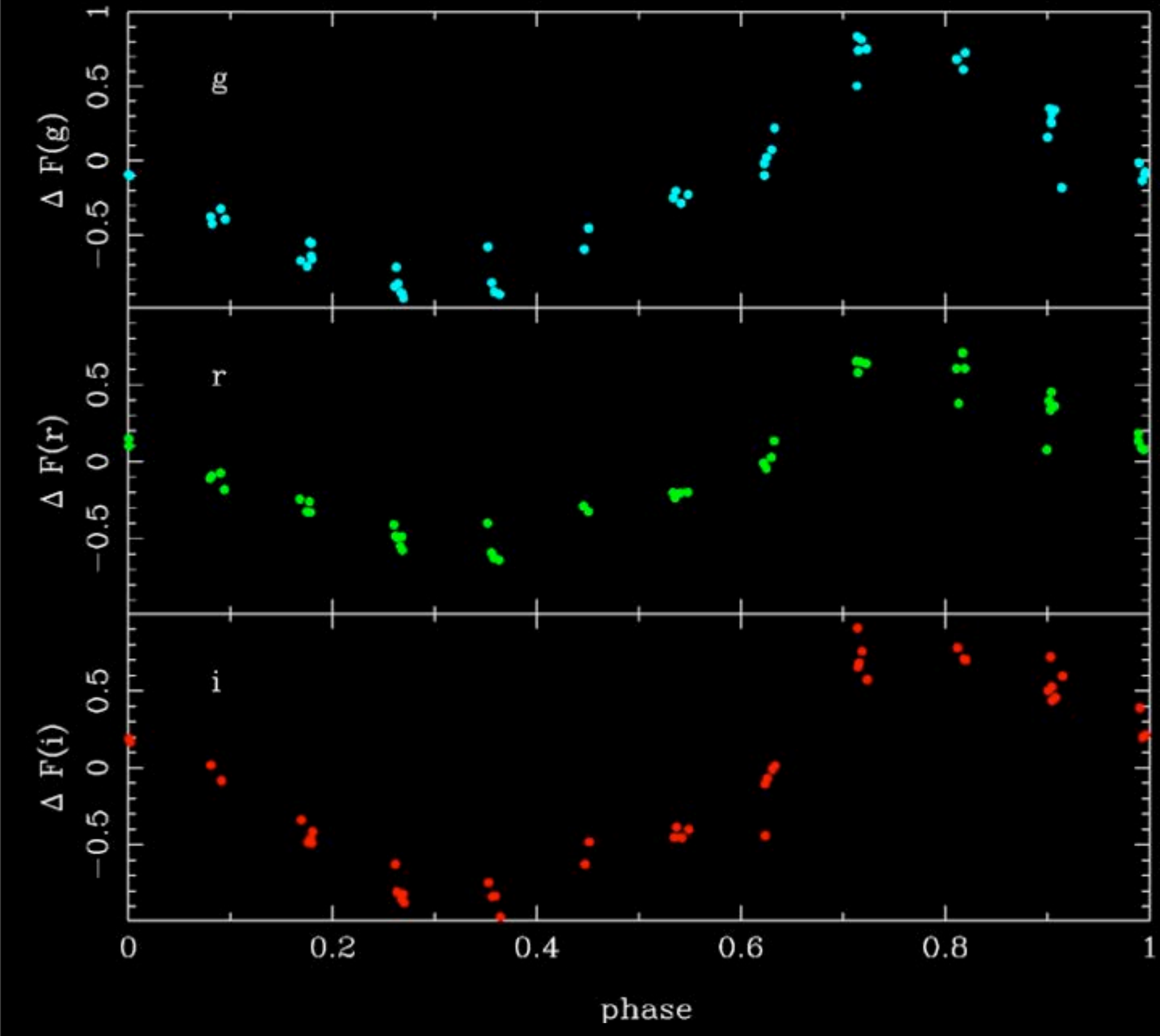
Backup Slides

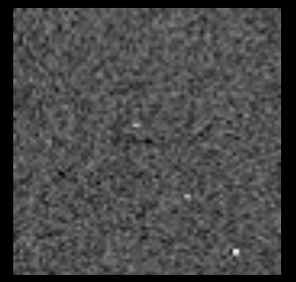
Spatial distribution
of 2460 cepheids
across the disc of M31





The POMME cepheids





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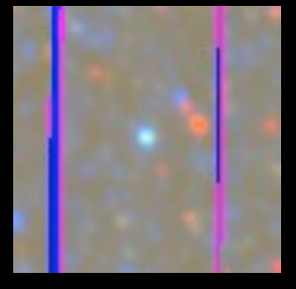

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National and international collaborations

LERMA
- D. Valls-Gabaud
- A. Tavant (stage X, gravitational microlensing)
- G. Thomas (PhD thesis Sep 2014+)

DIO/VOP
- R. Savalle (database and demonstrator)

IRAP - Toulouse
- J.F. Leborne (periodic variables)

Milano Brera
- E. Poretti (periodic variables)

IAC Canaries
- J. Fliri (periodic variables)

Obs. Athens / CfA Harvard
- A. Bonanos + M. Kournioutis (eclipsing binaries)

IfA Hawaii
- E. Magnier (spectroscopic follow-up at Keck+Gemini)

STScI / JHU
- A.G. Riess (HST follow-up)

Publications

Master theses

M. Kourniotis (MSc, Athens, 2013)
A. Tavant (stage X, gravitational microlensing, 2014)

PhD Theses

M. Kourniotis (Athens, eclipsing binaries, 2013+)
G. Thomas (Paris, SFR,EB,microlensing, 2014+)

Publications

- A.G. Riess, J. Fliri & D. Valls-Gabaud (2012) *Cepheid Period-Luminosity Relations in the Near-infrared and the Distance to M31 from the Hubble Space Telescope Wide Field Camera 3*, Astrophys. J., 745, 156

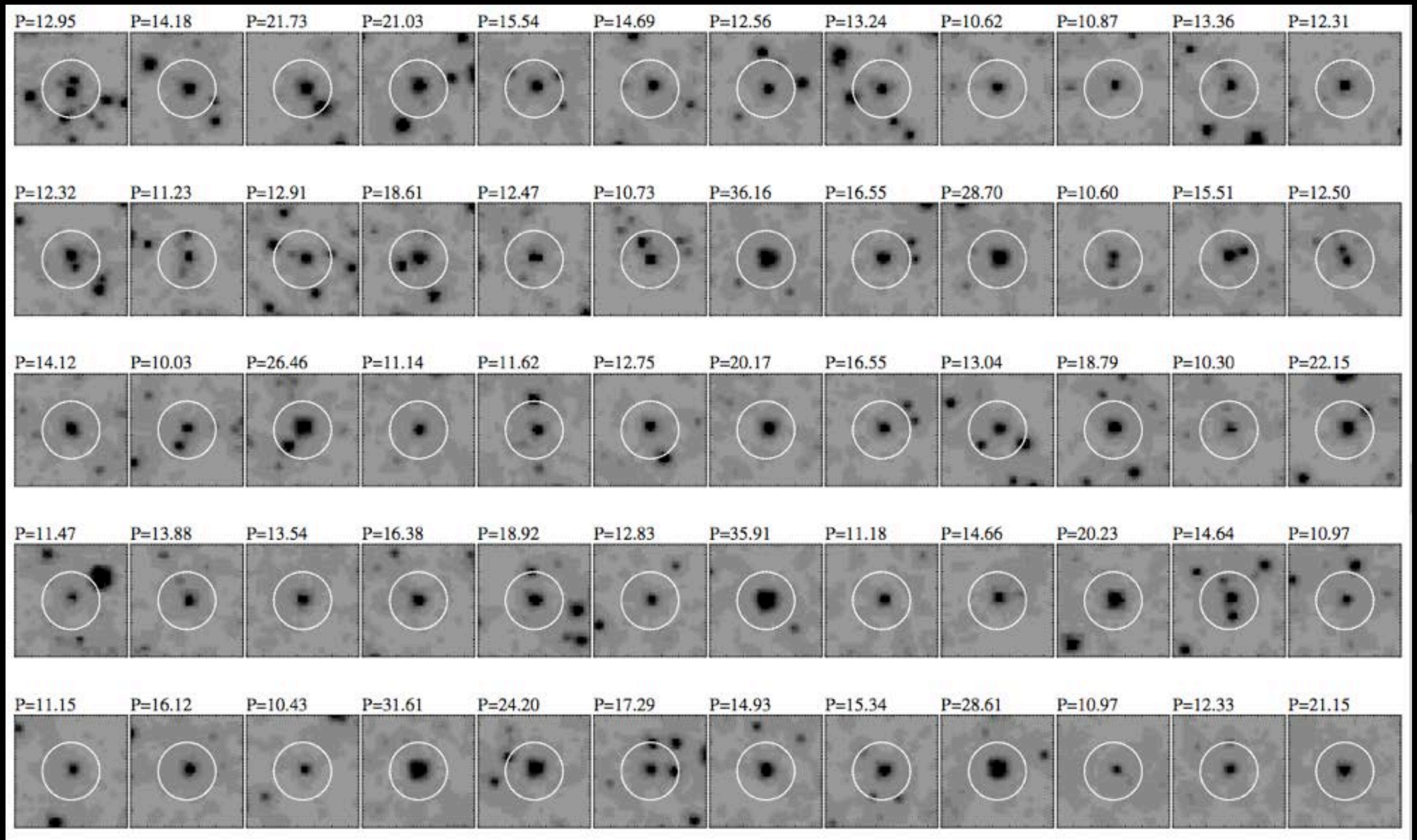
- J. Fliri & D. Valls-Gabaud (2012) *First results from the POMME survey of M31*, Astrophys. Space Sci. 341, 57

- D. Valls-Gabaud (2013) *The distance to M31 in the era of precision cosmology*, IAU Symposium 289 Advancing the physics of cosmic distances, Beijing,

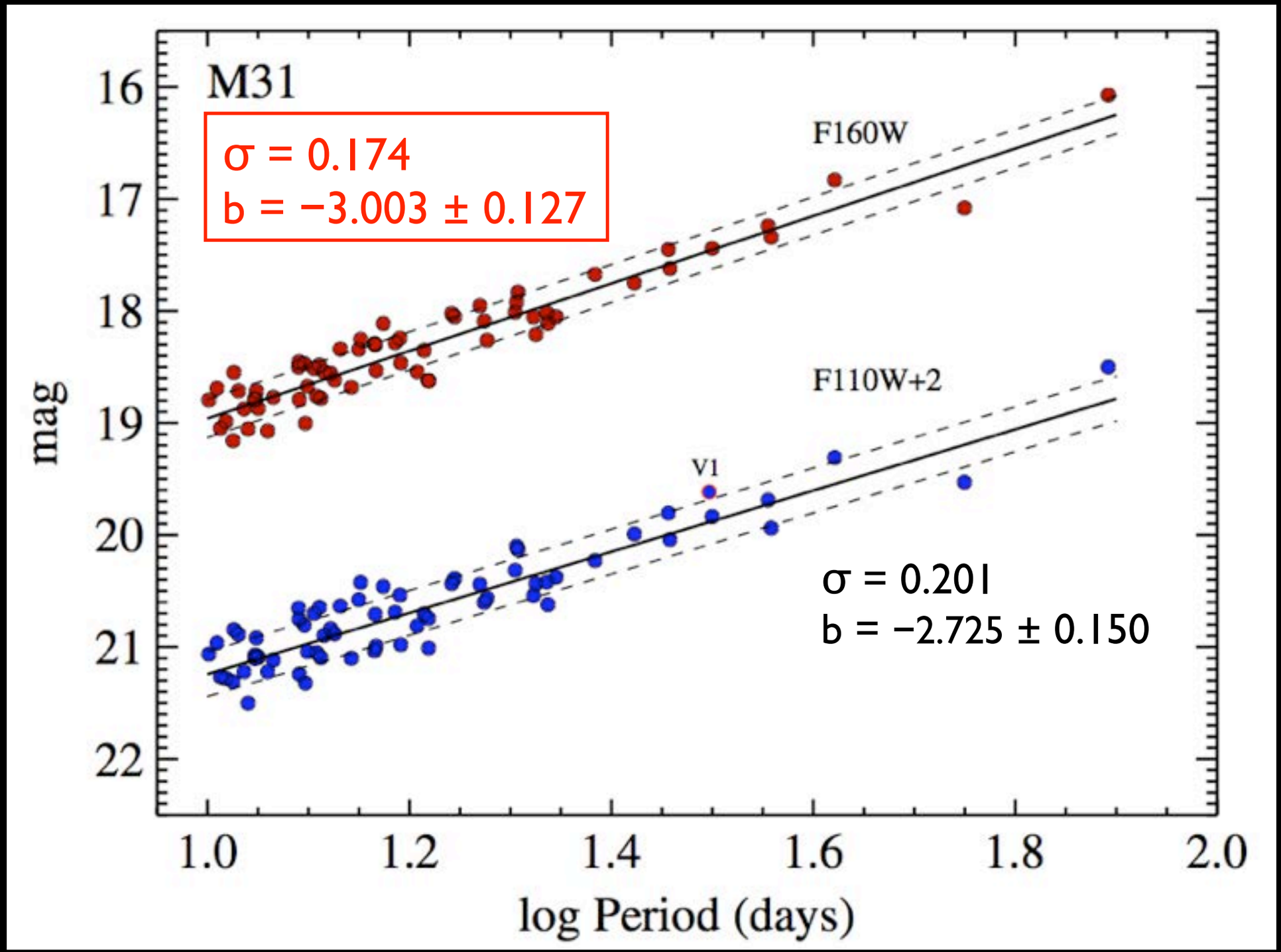
- T. Davidge, McConnachie, A. W.; Fardal, M. A.; Fliri, J.; Valls-Gabaud, D.; Chapman, S. C.; Lewis, G. F.; Rich, R. (2012) *The Recent Stellar Archeology of M31—The Nearest Red Disk Galaxy*, Astrophys. J., 751, 74

- J. Fliri, D. Valls-Gabaud, E. Magnier, R. Savalle (2014) *The POMME Survey I. Classical and first overtone cepheids*, in prep.

WFC3/HST images of POMME cepheids



Tightest Period-Luminosity-Colour (Leawitt) relation ever measured



Riess, Fliri & Valls-Gabaud (2012) *ApJ*, 745, 156