



DARK ENERGY
SURVEY

O Dark Energy Survey: de objetos trans-Netunianos à Cosmologia



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DES-Brazil

DES collaboration

LineA Bootcamp, 9/2019



Breve histórico do projeto

- Proposta ao NOAO – 07/2004
- Construção da DECam : 10/2012
- Science Verification: 11/2012 a 02/2013
- Coleta de dados: 8/2013 a 1/2019
- Primeiro data release: 7/2018 (DES Collaboration, ApJS, 239, 18)
- Previsão para data release final: 2021?

Membros do DES

- 25 instituições/grupos, incluindo o consórcio DES-Brazil (LineA) → 7 países (EUA, UK, Espanha, Brasil, Alemanha, Suiça, Austrália)
- 400+ pesquisadores

Participação brasileira

- Consórcio DES-Brazil: 10 pesquisadores seniors + Pos-Docs, estudantes
- Contribuição para infra-estrutura: Quick Reduce, Quality Assurance, Tile Viewer, Portal Científico → 9 builders do DES
- Das 13 teses do LineA, >7 usaram dados do DES
- Pelo menos metade das 19 dissertações também

DES Collaboration Meeting

Campinas, Brasil, 12/2018





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Dark Energy Survey (DES)

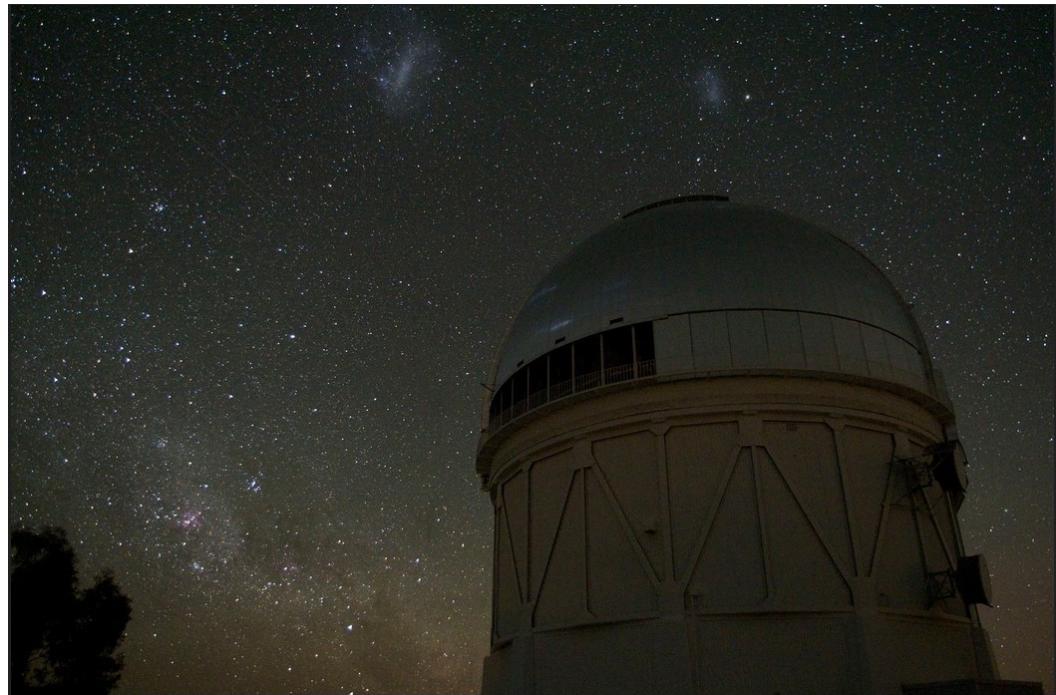


Photometric survey in several filters:

- 5000 deg² in grizY down to $\text{gri} \approx 24$ mag, $z \sim 23$, $Y \sim 21.5$
- 30 deg²: 5 exp/month → SNe search

Initiated on 31/08/2013

Terminated on 01/2019



CTIO – 4m Telescope

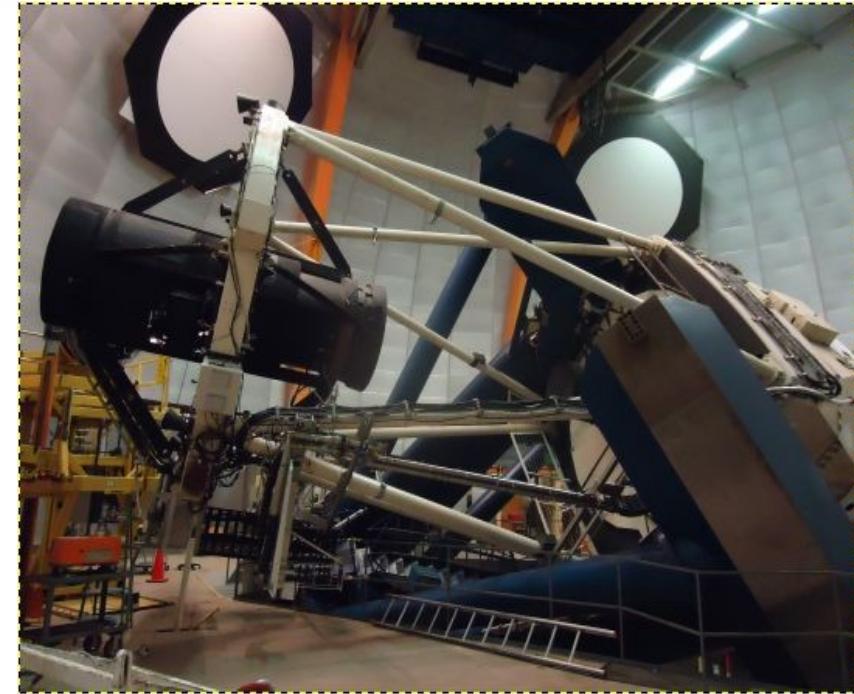
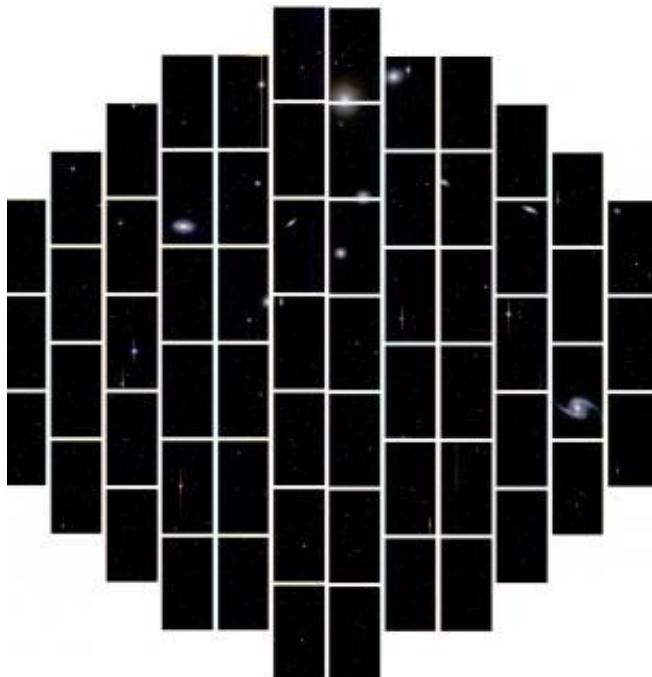


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A Dark Energy Camera (DECam)



- 62 red sensitive CCDs
- A field of 3 deg^2
- On PF of 4m at CTIO

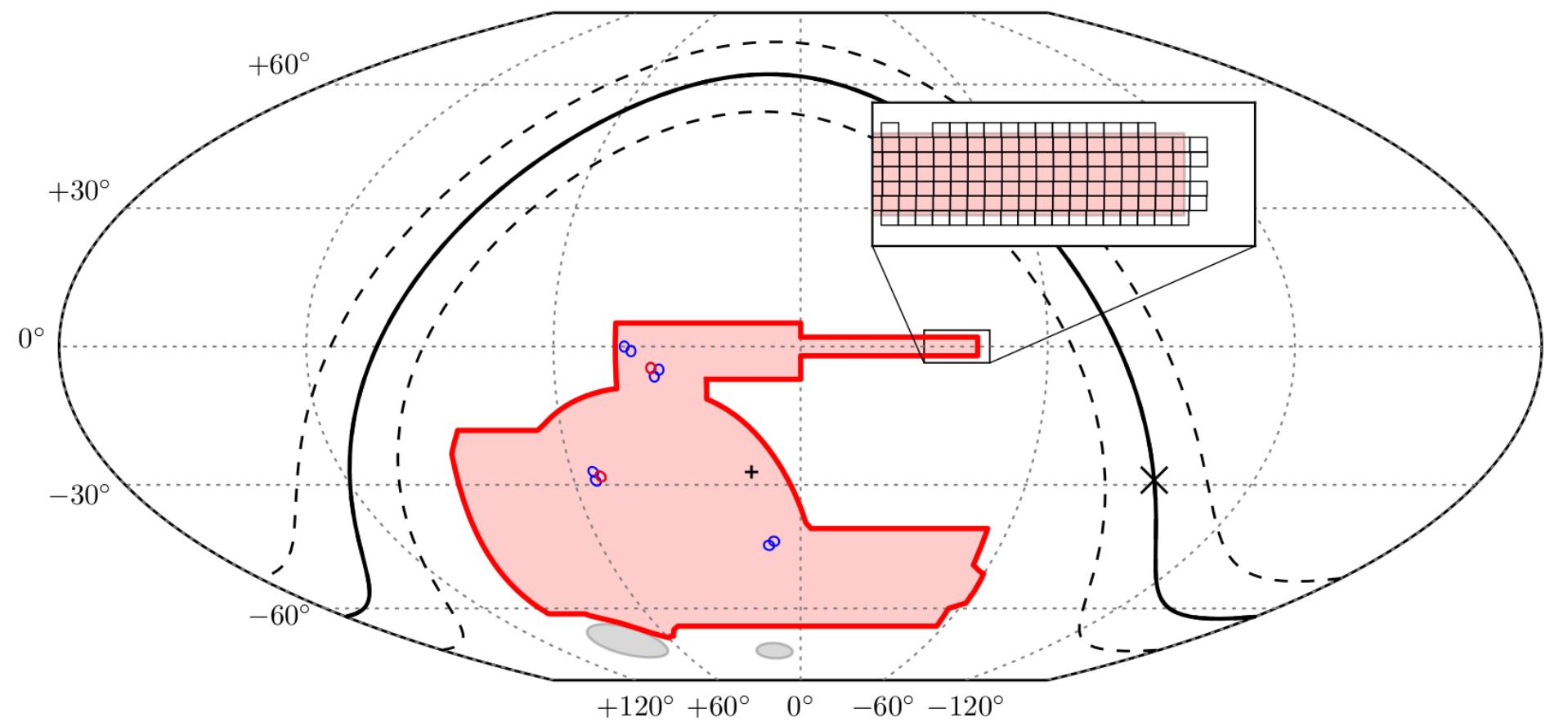


1st light in 09/2012

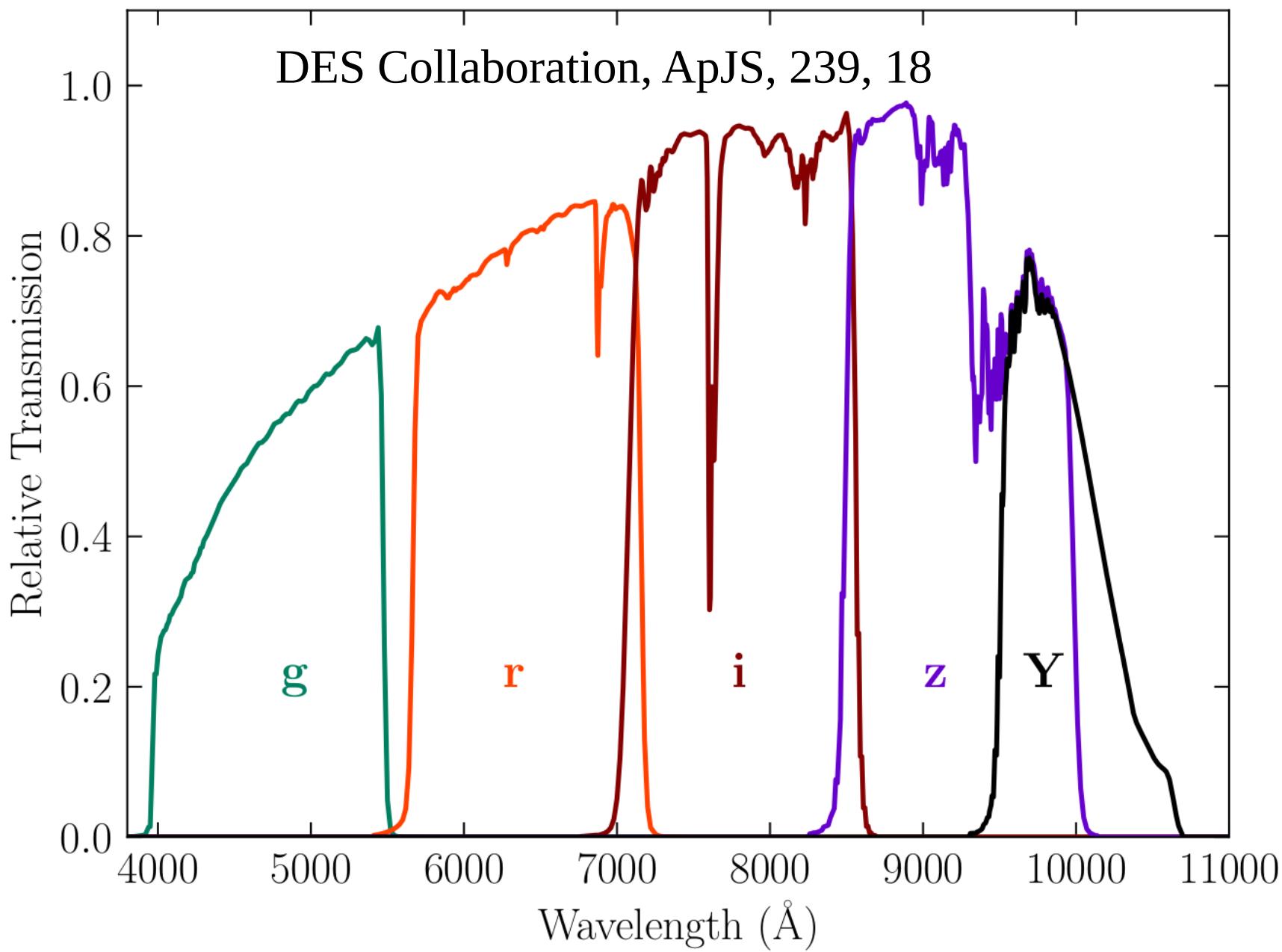
Science verification from 09/2012 to
02/2013

Região coberta (footprint)

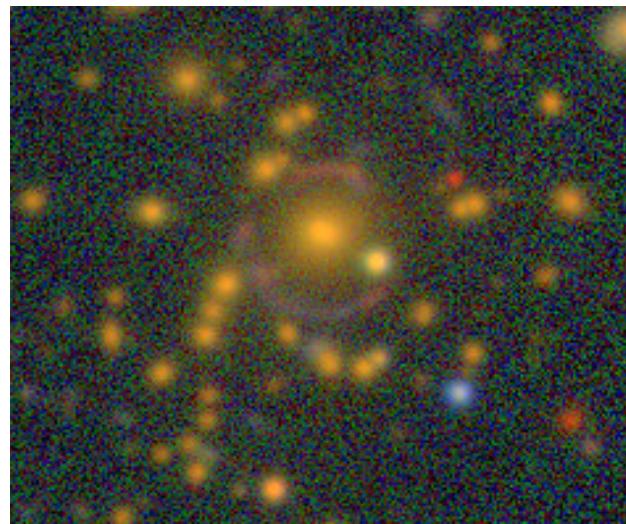
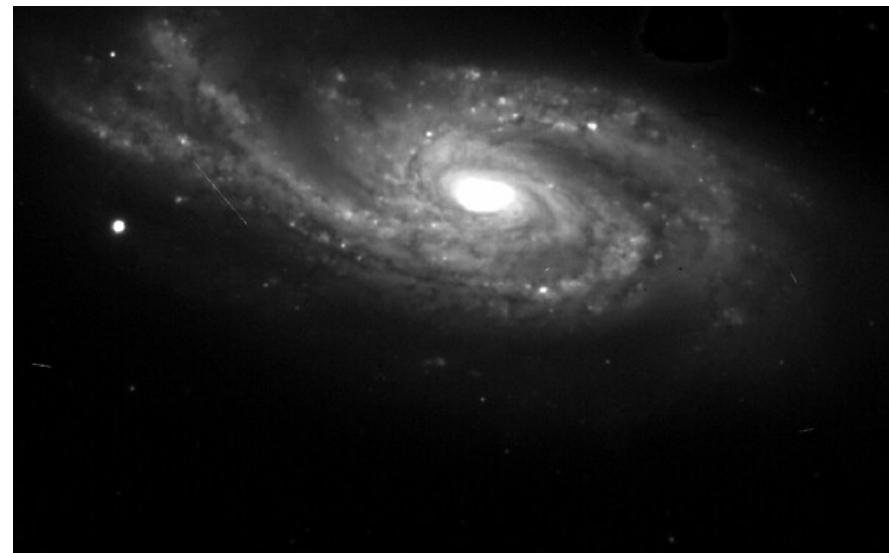
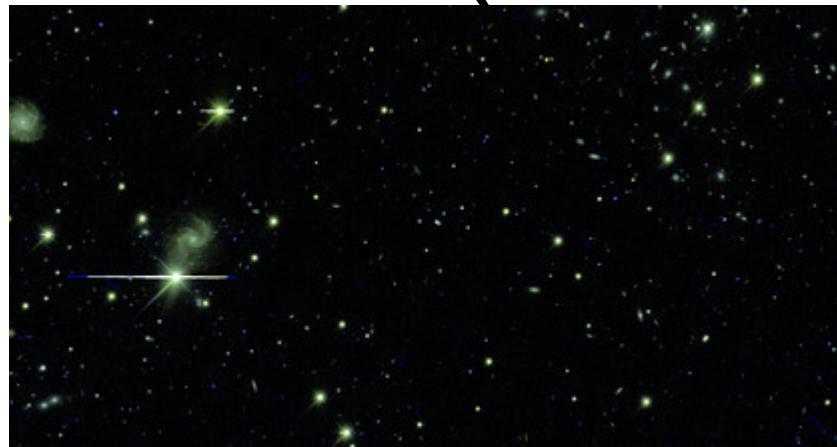
DES Collaboration, ApJS, 239, 18



DECam filters



DECam images (DES Image Gallery)





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SURVEY



DES in numbers

- 150+ scientists from >20 institutions; 400+ people total
- 20+ people only in the DES Data Management (DESDM)
- 525 nights at CTIO/DECam (late 2013-early 2018 + Y6: 2018/2019)
- ~ 300 Gb of raw data per night
- ~ few Pb of data in total
- ~ 3×10^8 galaxies
- ~ 10^8 stars
- ~ 10^6 QSOs, ~ 10^5 galaxy clusters, ~ 10^3 gravitational arcs, and a lot more...

DES Science

- Focus on Cosmology (but it is not a Cosmological project) → Ω_m , Ω_{DE} , w
- Ancillary Science: Stellar Populations, QSOs, Galaxy Evolution, Strong Lensing, Solar System objects...
- MW science: $\sim 10^8$ stars, most of them in MW thick disk and halo (Rossetto et al 2011).

Standard Cosmology

Probing Dark Matter & Dark Energy

- ◆ Through the **history of the expansion rate**:

$$H^2(z) = H_0^2 [\Omega_M (1+z)^3 + \Omega_{DE} (1+z)^{3(1+w)}] \quad \begin{matrix} \text{matter} & \text{dark energy} & \text{(constant } w\text{)} \end{matrix}$$

$$P = w \rho$$

- ◆ Comoving distance $r(z) = \int dz/H(z)$
- ◆ Standard Candles $d_L(z) = (1+z) r(z)$
- ◆ Standard Rulers $d_A(z) = (1+z)^{-1} r(z)$
- ◆ The **rate of growth of structure** also determined by $H(z)$ and by any modifications of gravity on large scales

Courtesy of: Ofer Lahav (UCL/UK)



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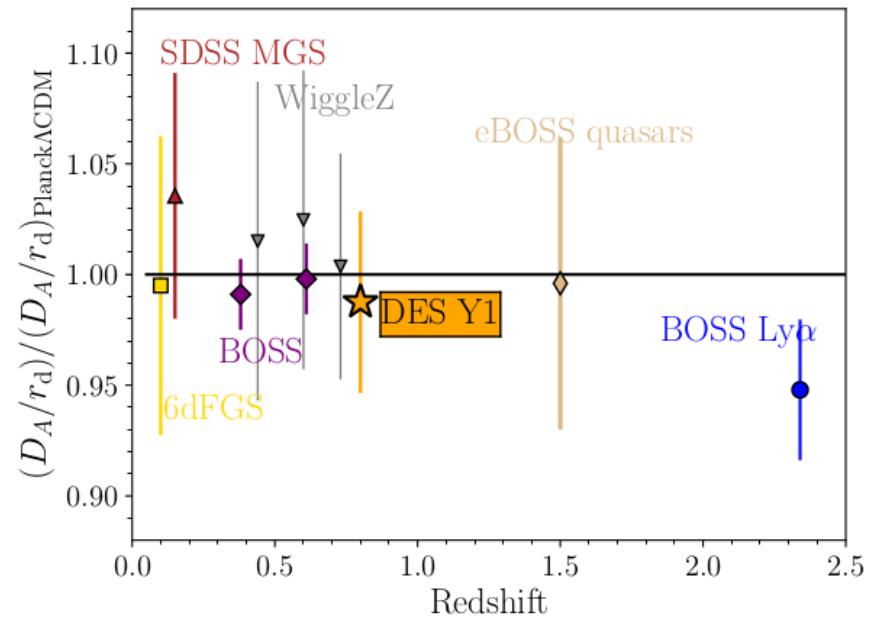
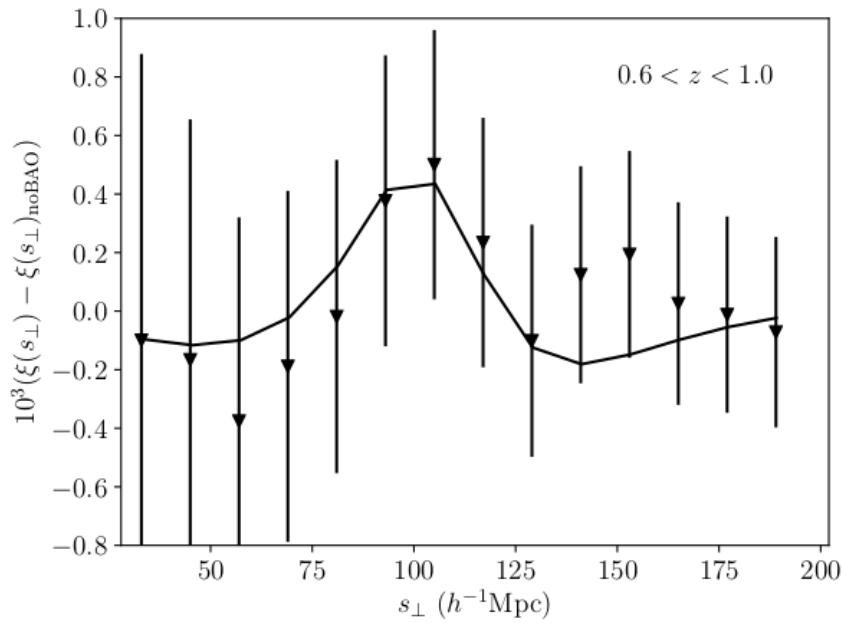


DES and dark energy

Four basic tools to constrains cosmological parameters
 $(\Omega_{DE}, \Omega_m, w \text{ (ou } w_0, w_a))$:

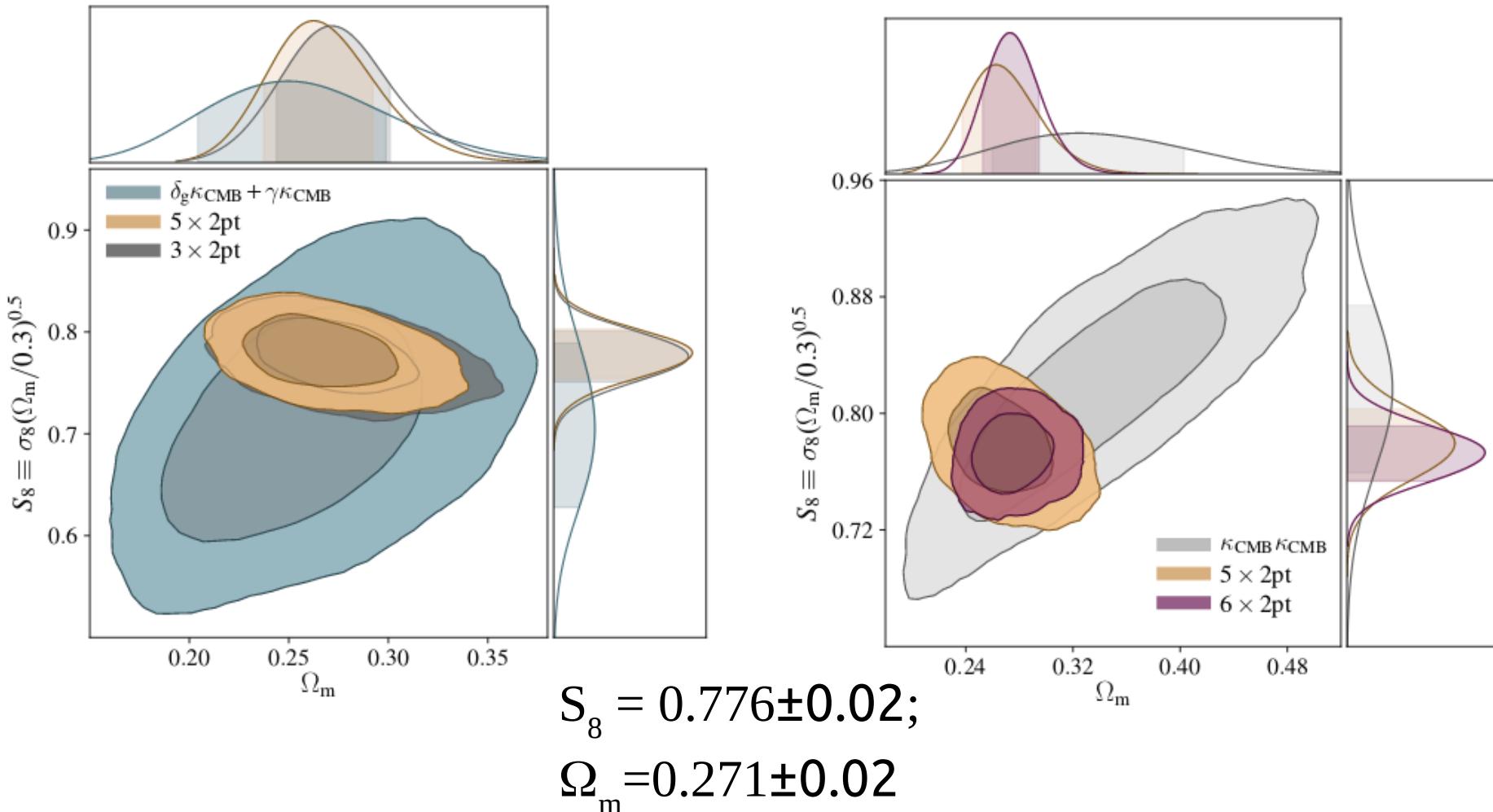
- Supernovae Ia → std candles → luminosity distance (d_L) - *redshift (z) relation.*
- Number of galaxy clusters ($N_{gal}(z)$) → structure growth → $H(z)$
- Large scale structure: correlation *statistics* → *growth of structure* → $H(z)$; clustering scales: ex.: BAOs (standard rule) → angular distance (d_A) - *redshift (z) relation.*
- Weak gravitational lensing: shear maps → *growth of structure* → $H(z)$

Baryonic Acoustic Oscilations from DES Y1 data



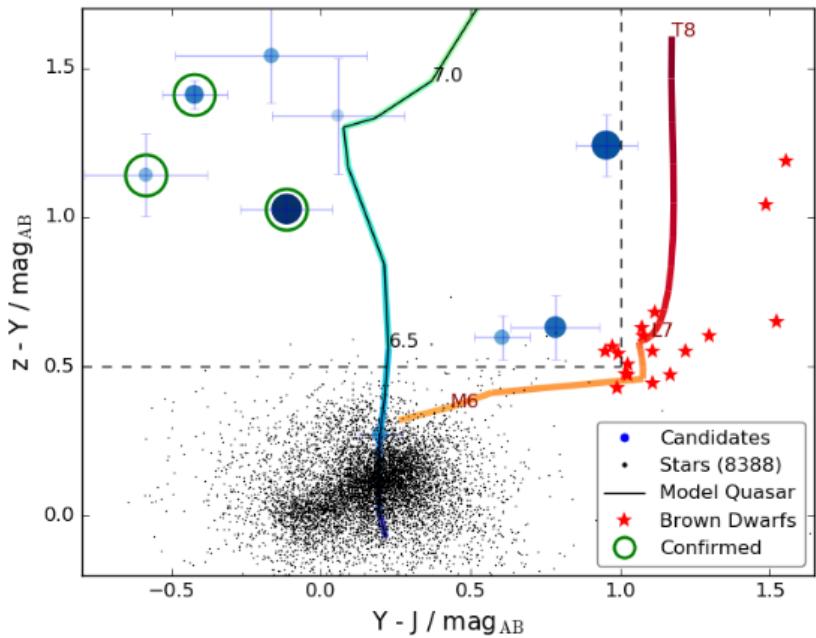
DES Collaboration 2019, MNRAS, 483, 4866

Galaxy Clustering DES + CMB

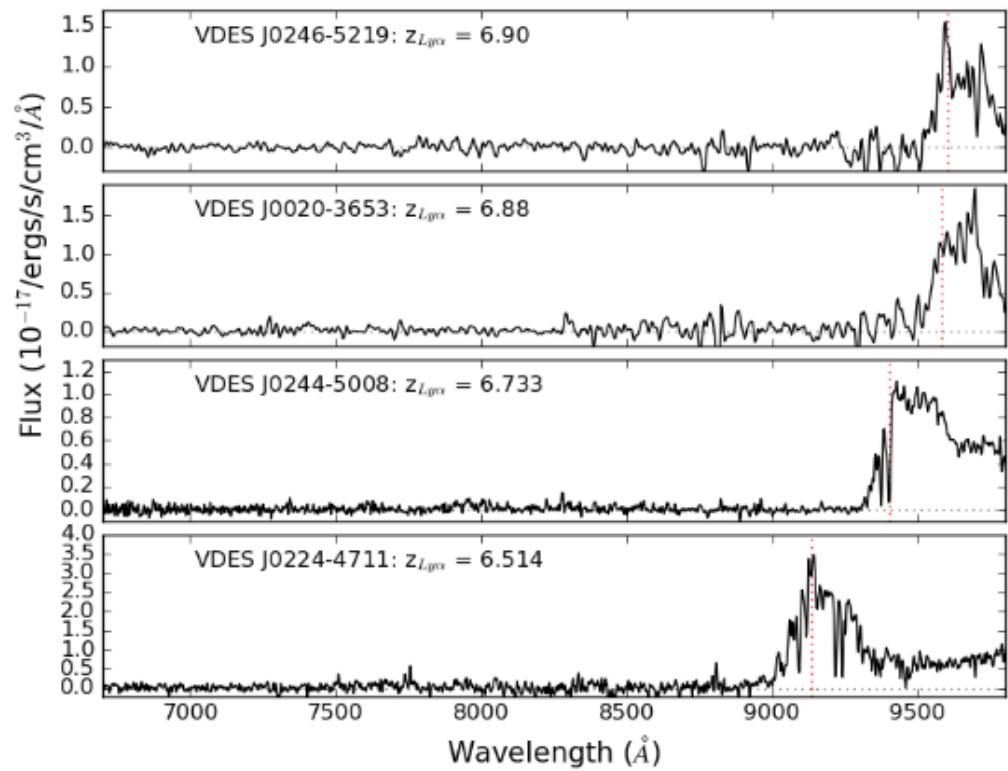


DES Collaboration, Physical Review D, Volume 100, Issue 2,
id.023541

High-z Quasars

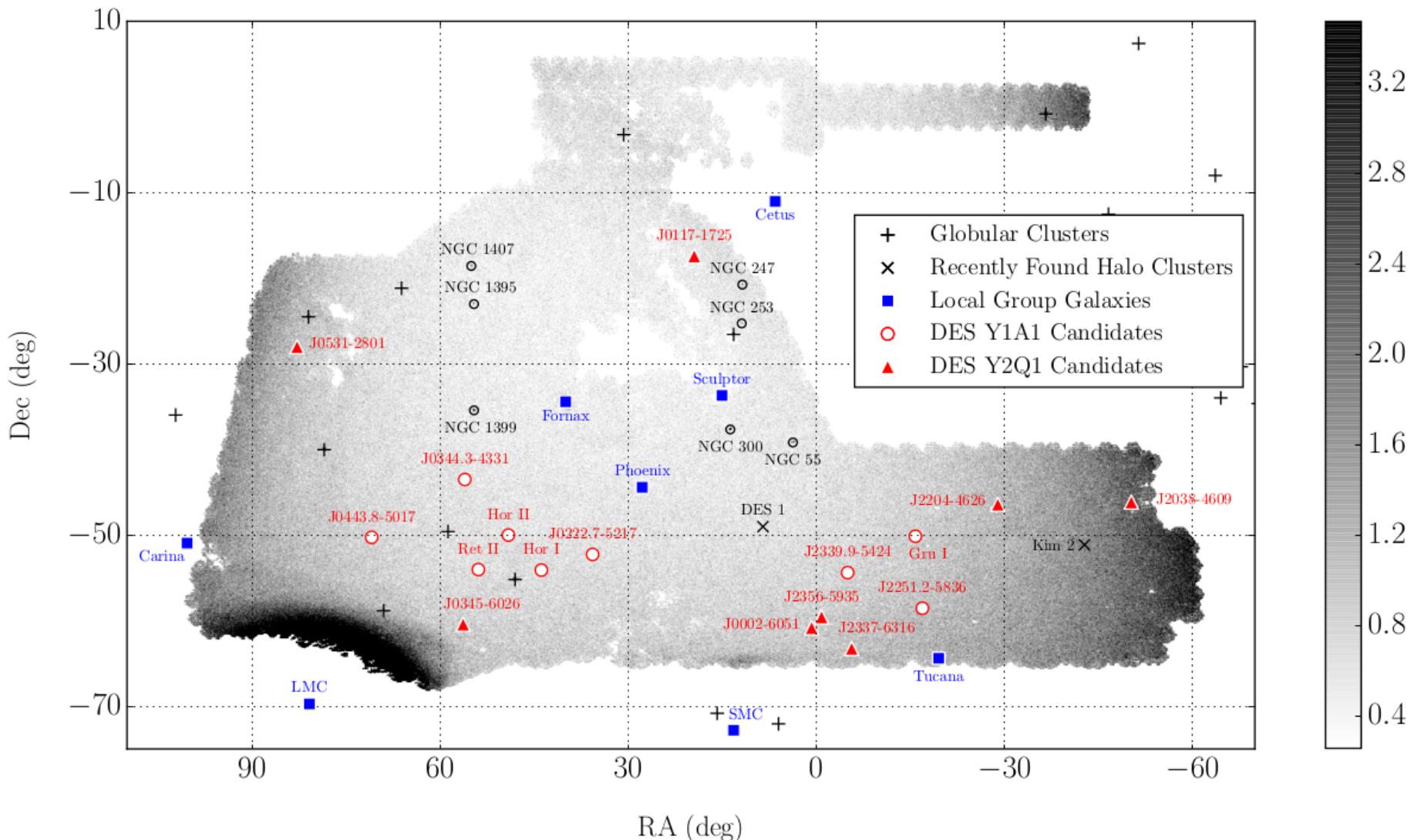


Reed et al 2019, MNRAS,
487, 1874



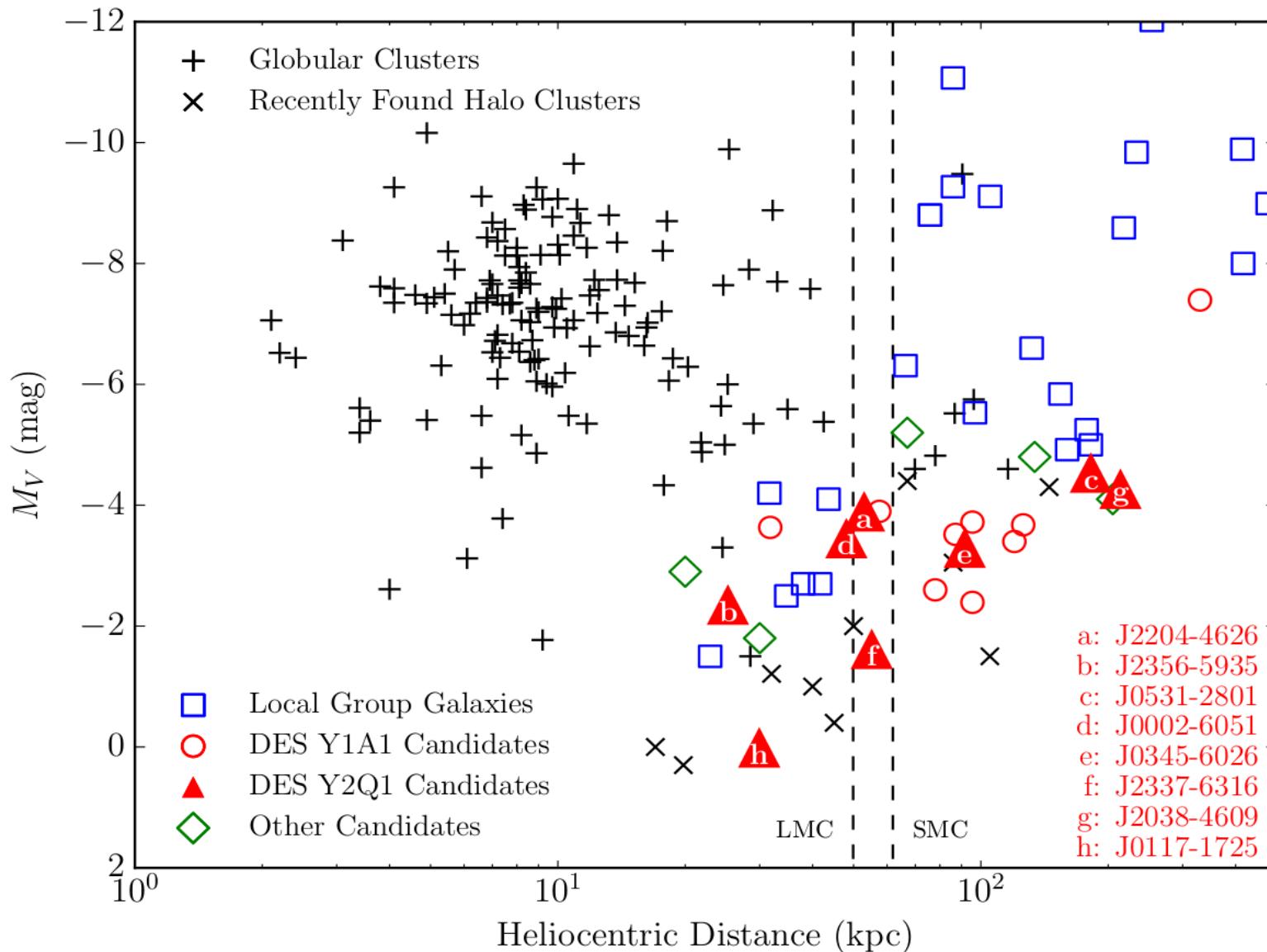
New Ultra-faint dwarfs galaxies (UFDs)

DES Collaboration 2015, ApJ, 813, 109



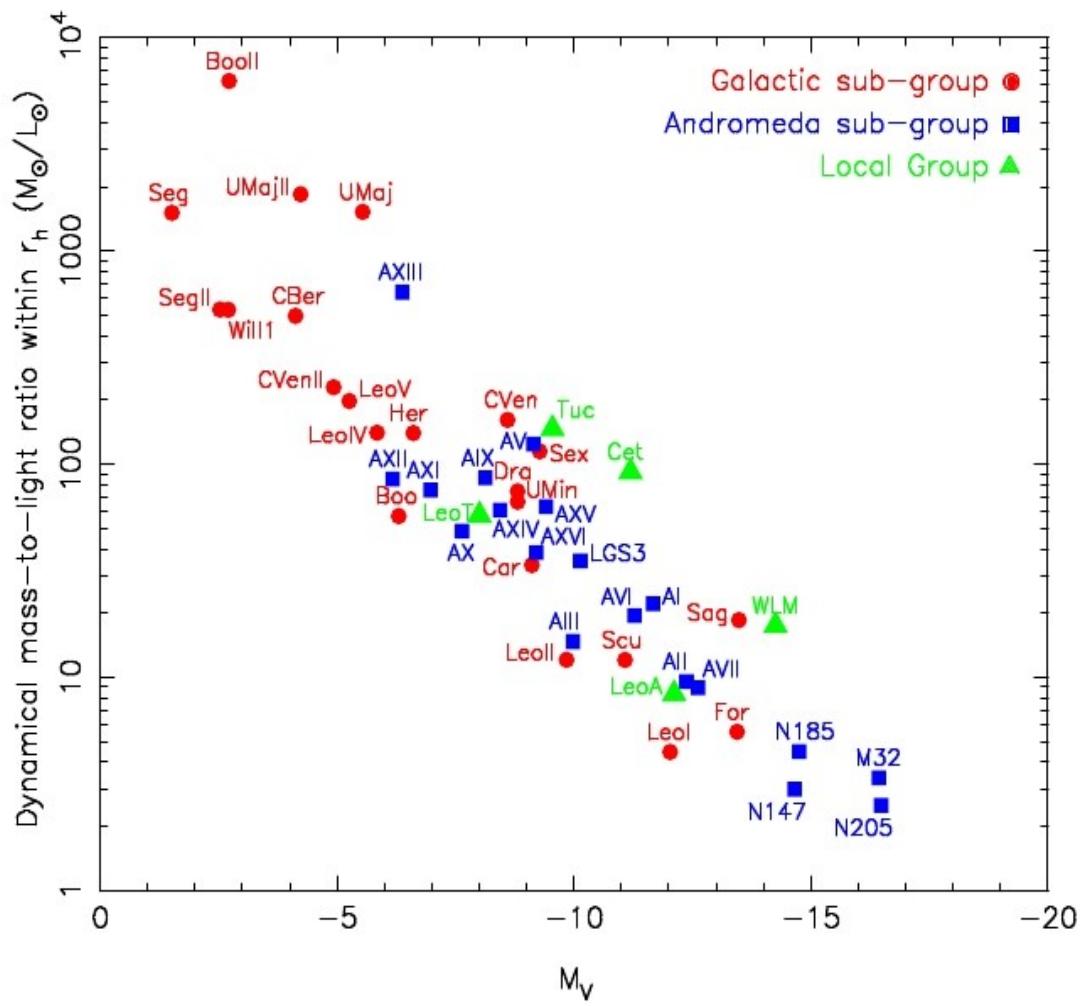
UFDs: Luminosity vs distance

DES Collaboration 2015, ApJ, 813, 109



UFDs – dark matter rich

- DM rich
- Candidates for DM subhalos seen in simulations
- Promissing sites of DM annihilation → DM particles

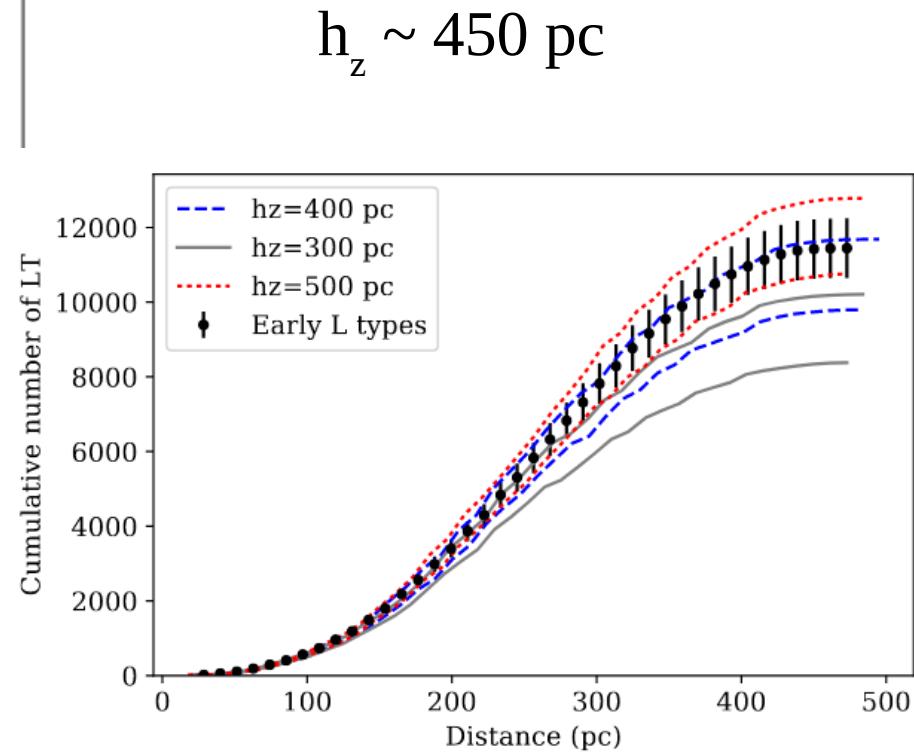
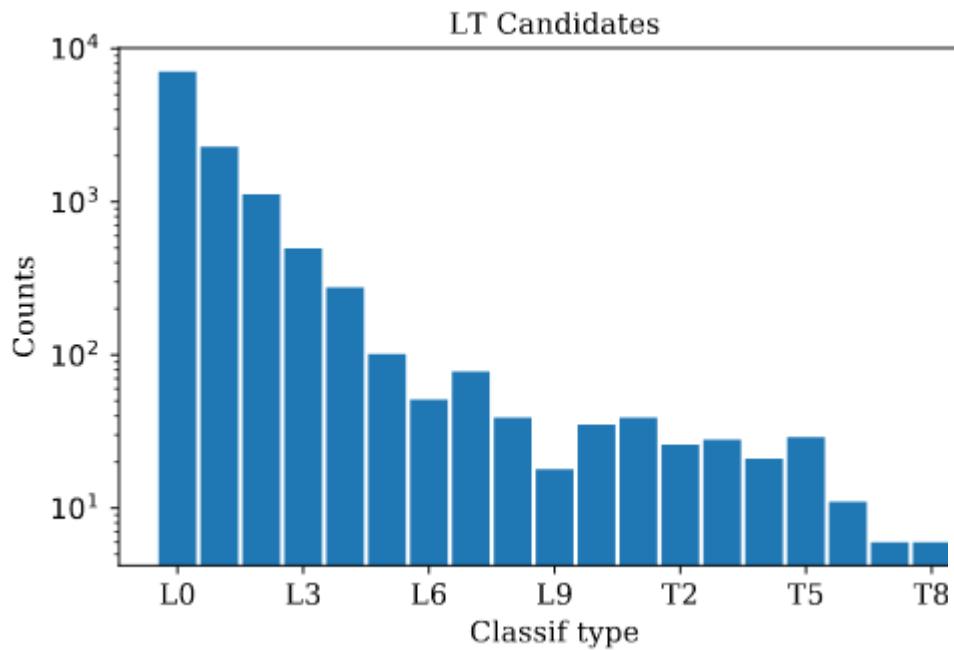


Several other MW related results

- >100 novos aglomerados estelares nas regiões externas da Grande Nuvem de Magalhães (LMC), Pieres et al 2015
- Estrutura do disco externo da LMC (Balbinot et al 2014)
- Novos aglomerados estelares distantes do Halo da MW: Luque et al 2016, 2018
- Candidatas a anãs ultra-tênuas satélites da anã de Sagitário: Luque et al 2017
- Vários candidatos a correntes e nuvens estelares da MW: Shipp et al 2018, Balbinot et al 2016, Li et al 2016
- Subestrutura estelar nas regiões externa da Pequena Nuvem de Magalhães, Pieres et al 2017.

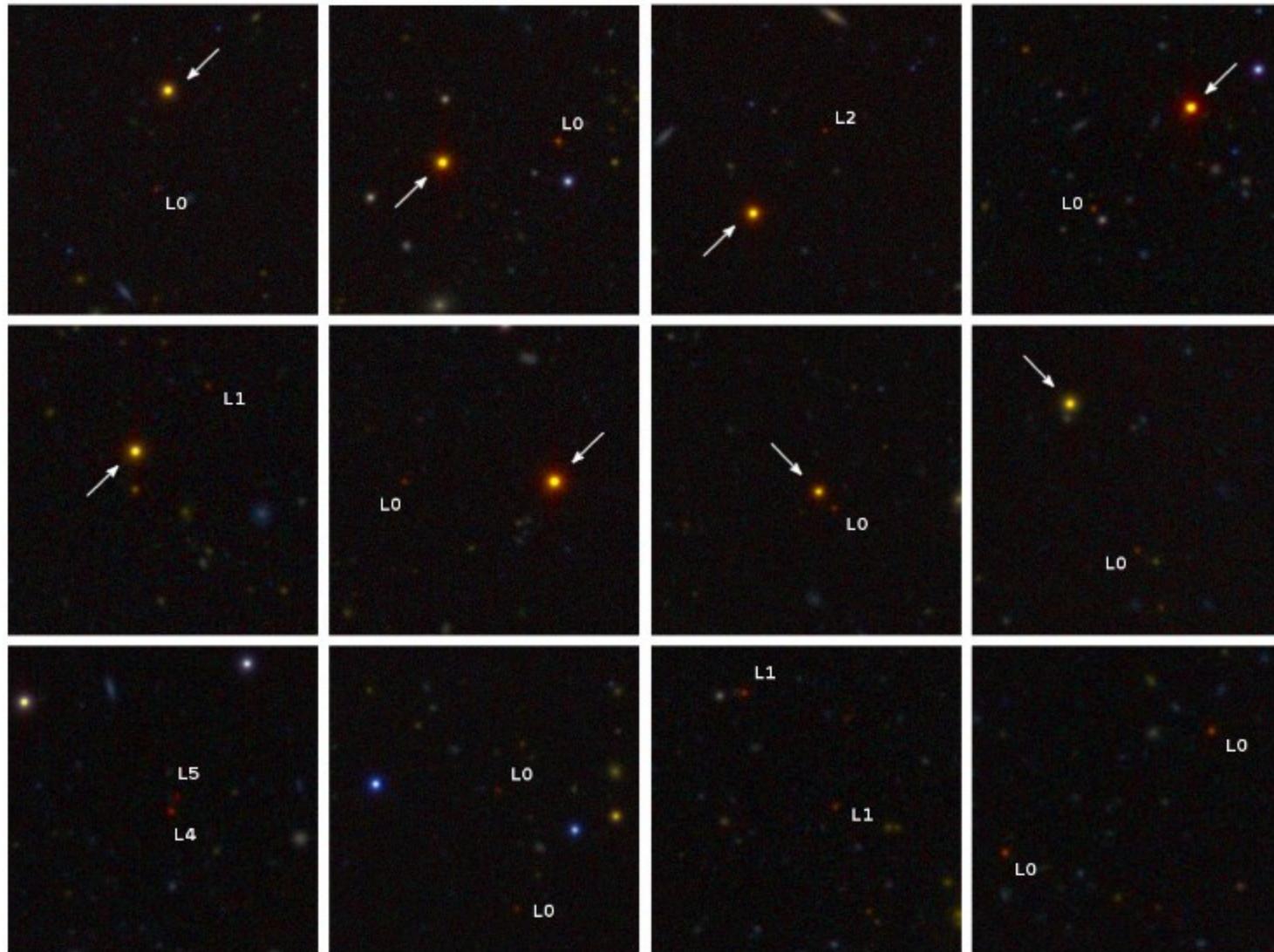
Largest sample of L/T dwarfs

Carnero-Rossell et al. 2019, MNRAS, in press: > 11700 L/T candidates.



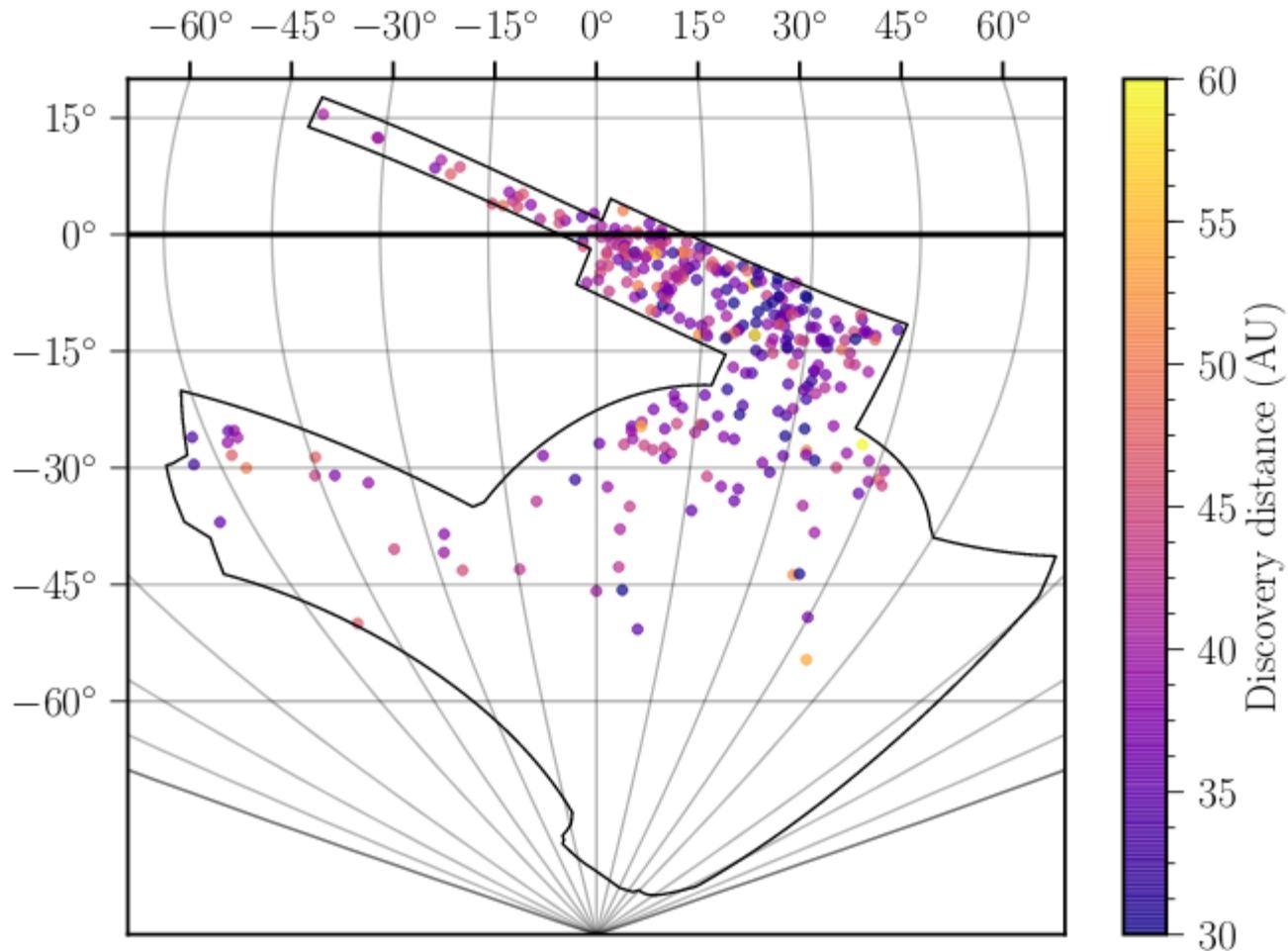
L/T dwarfs in wide binary systems

(Dal Ponte et al 2019, in prep.)



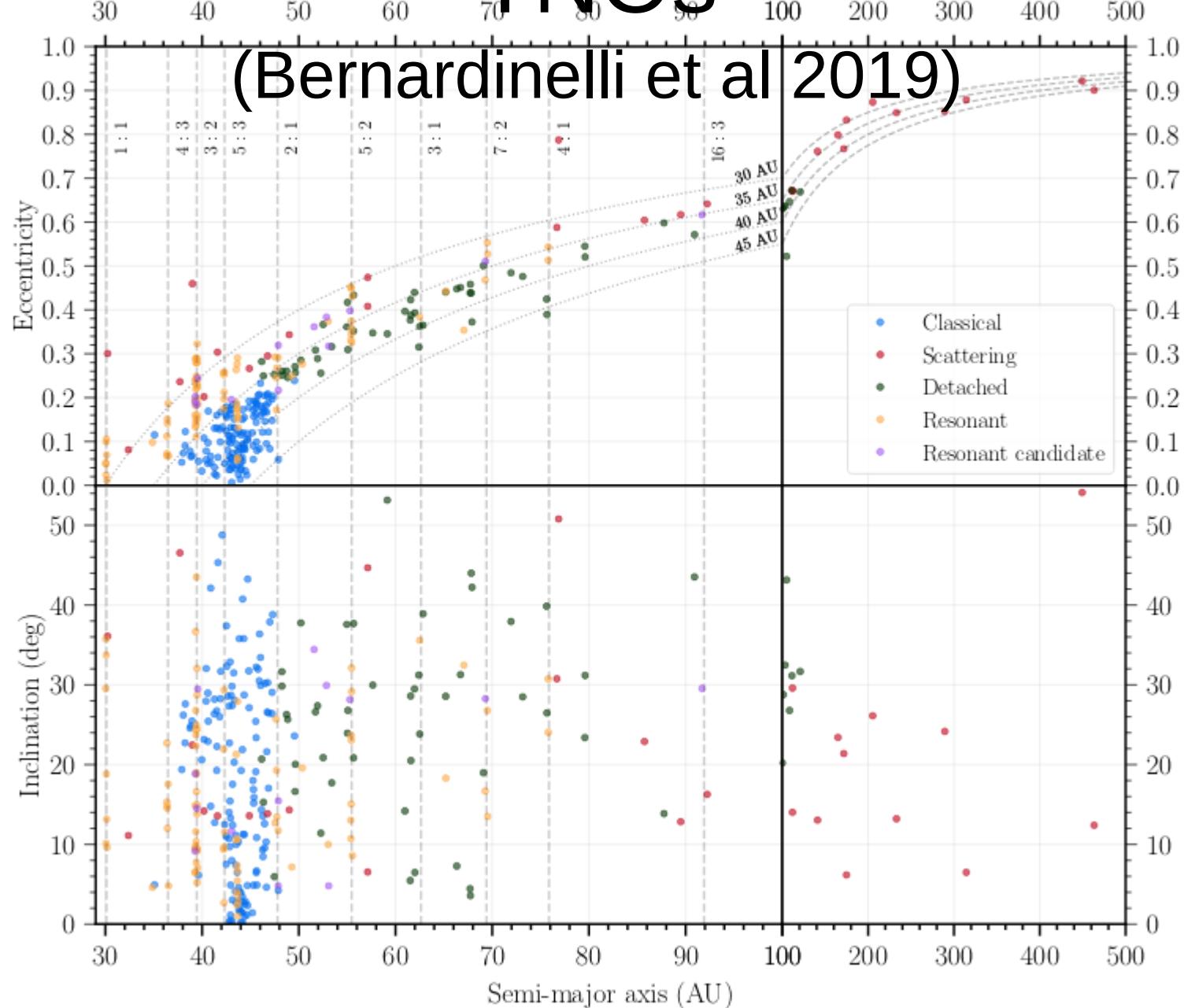
Objetos Transnetunianos (TNOs)

(Bernardinelli et al 2019)



TNOs

(Bernardinelli et al 2019)

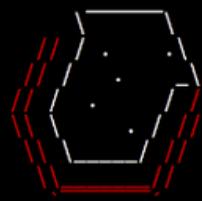


DES data access

Marina Dal Ponte

Easyaccess

- **easyaccess** is an enhanced command line interpreter and Python package created to facilitate access to the data stored in SQL Databases
- For a short tutorial of installation and documentation:
[http://matias-ck.com/easyaccess/#/
Home](http://matias-ck.com/easyaccess/#/Home)
- To create an account:
[https://des.ncsa.illinois.edu/easyweb/
signup/](https://des.ncsa.illinois.edu/easyweb/signup/)



DARK ENERGY SURVEY
DATA MANAGEMENT

```
easyaccess 1.4.5. The DESDM Database shell.  
Connected as mcarras2 to dessci.  
** Type 'help' or '?' to list commands. **  
DESSCI ~> █
```

<https://github.com/mgckind/easyaccess/>

DES data access

Marina Dal Ponte

DES Labs

To access the web page use the same user and password as the easyaccess.

The screenshot shows the DES Labs web interface. At the top, there's a logo of a hexagon with red and blue lines, followed by the text "DARK ENERGY SURVEY desaccess". On the left, a sidebar menu lists: Home (selected), DB access, DES Table Schema, Example Queries, Cutouts Service, DES JupyterLab, Finding Chart, and DES Footprint. The main content area has a "Welcome to dessci, Marina!" message. It features several cards: "DB ACCESS" (Oracle SQL web-client, More...), "DES TABLE SCHEMA" (Browse all tables, More...), a thumbnail of a galaxy image, a "jupyter" logo, and a "EXAMPLE QUERIES" section with sample SQL code and a "More..." link.

DARK ENERGY SURVEY desaccess

Welcome to dessci, Marina!

mdalpont
mari.dalponte@gmail.com

Home

DB access

DES Table Schema

Example Queries

Cutouts Service

DES JupyterLab

Finding Chart

DES Footprint

DB ACCESS

Oracle SQL web-client

More...

DES TABLE SCHEMA

Browse all tables

More...

SELECT dr1.RA,dr1.DEC,dr1.COADD_OBJECT_ID
FROM dr1_main sample(0.01) dr1
WHERE
dr1.MAG_AUTO_G < 18 and
dr1.WAVG_SPREAD_MODEL_I + 3.0*dr1.WAVG_SPREADERR_M
dr1.WAVG_SPREAD_MODEL_I + 1.0*dr1.WAVG_SPREADERR_M
dr1.WAVG_SPREAD_MODEL_I + 1.0*dr1.WAVG_SPREADERR_R
dr1.WAVG_SPREAD_MODEL_I > -1 and
dr1.IMAFLAGS_ISO_G = 0 and
dr1.IMAFLAGS_ISO_R = 0 and
dr1.IMAFLAGS_ISO_I = 0 and

EXAMPLE QUERIES

See some example queries as a start

More...

jupyter

© 2018, DESDM Release Team (NCSA) version : 2.0.0-jun5-31965a [Terms and Conditions](#)

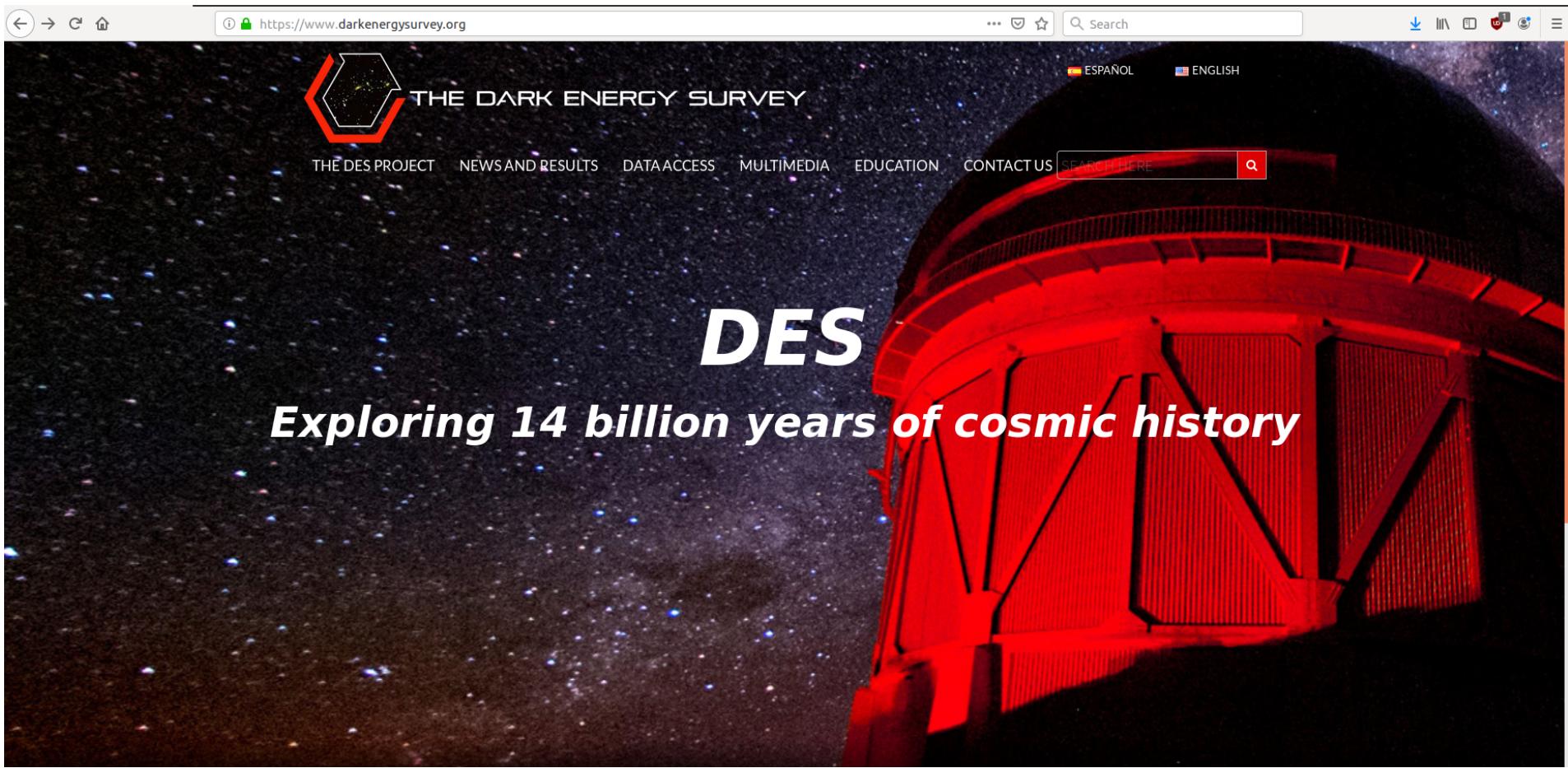
<http://deslabs.ncsa.illinois.edu/easyweb/>

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- Dark Bites
(<https://www.darkenergysurvey.org/education/darkbites/>)
- Scientist of the week
- Galeria de figuras e videos

Mais informações

<https://www.darkenergysurvey.org/>



The DES Book

(finalizado em 04/2019, World Scientific)

The Dark Energy Survey: The Story of a Cosmological Experiment

Editors
Ofer Lahav, Lucy Calder,
Julian Mayers, Josh Frieman

Dedication: To everyone who has been involved in DES