ESCAPE
European Science Cluster of Astronomy & Particle physics ESFRI research Infrastructures

Conference **ESCAPE to the Future** | 25-26 October 2022

Royal Belgian Institute of Natural Sciences | Brussels, Belgium

25 October 2022, 15:40 - 16:35

ESCAPE Citizen Science to enhance scientific research

ESCAPE CS | Citizen Science

Stephen Serjeant
Open University

Gwenhaël de Wasseige
KM3NeT

JIVE Joint Institute for VLBI ERIC

Martin Hardcastle
University of Hertfordshire

SKAO

James Pearson
Open University

VERA C. RUBIN OBSERVATORY | LSST Legacy Survey of Space and Time

Hugh Dickinson
Open University

VERA C. RUBIN OBSERVATORY | LSST Legacy Survey of Space and Time

ESCAPE
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ESCAPE to the Future
25-26 October 2022
Brussels, Belgium

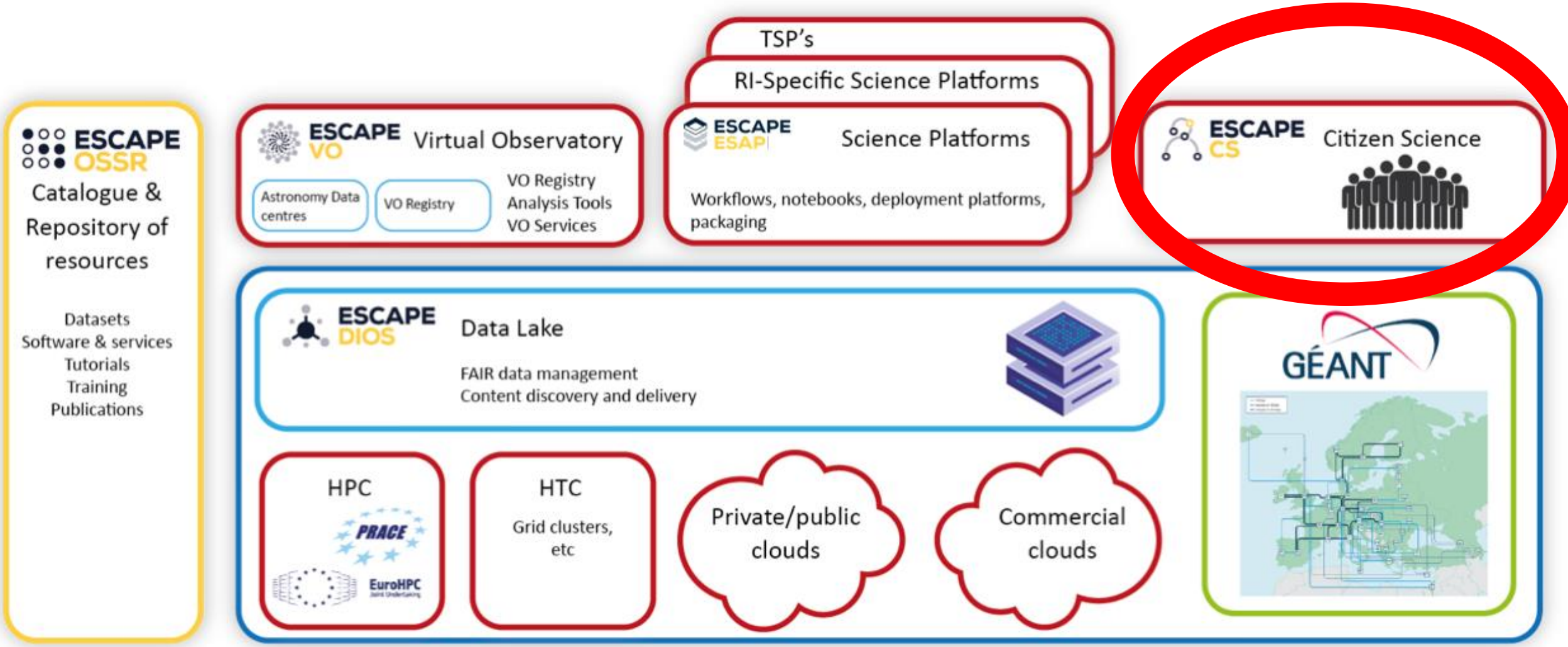
ESCAPE to the Future: Citizen Science

Stephen Serjeant, for: Rita Meneses, James Pearson, Hugh Dickinson, Luigi Colucci, Maud Coppel

ESCAPE Final Event, Brussels, 25th Oct 2022

ESCAPE - The European Science Cluster of Astronomy & Particle Physics ESFRI Research Infrastructures has received funding from the European Union's Horizon 2020 research and innovation programme under Grant Agreement no. 824064.

Improve access to data and tools through citizen science crowdsourcing experiments for most of the facilities in the ESCAPE remit.



Based on slide by G. Lamanna

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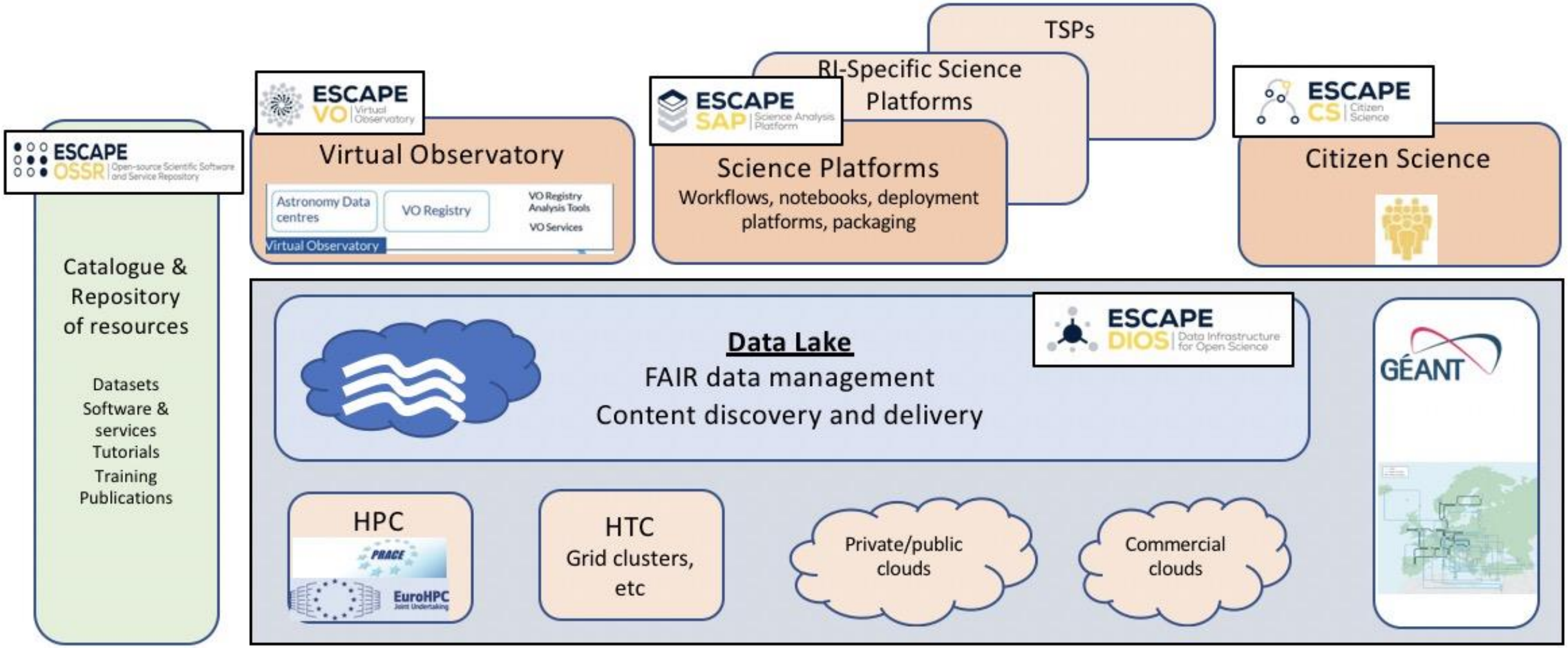

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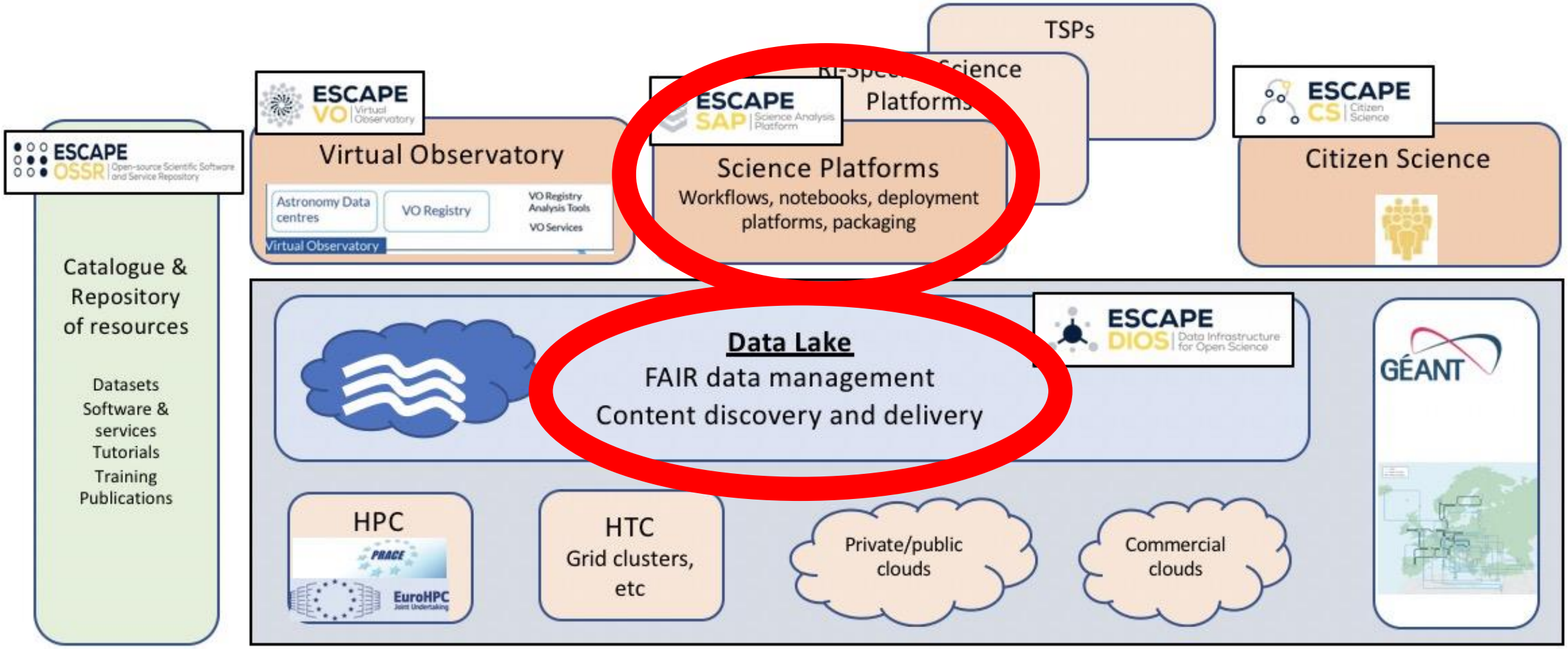

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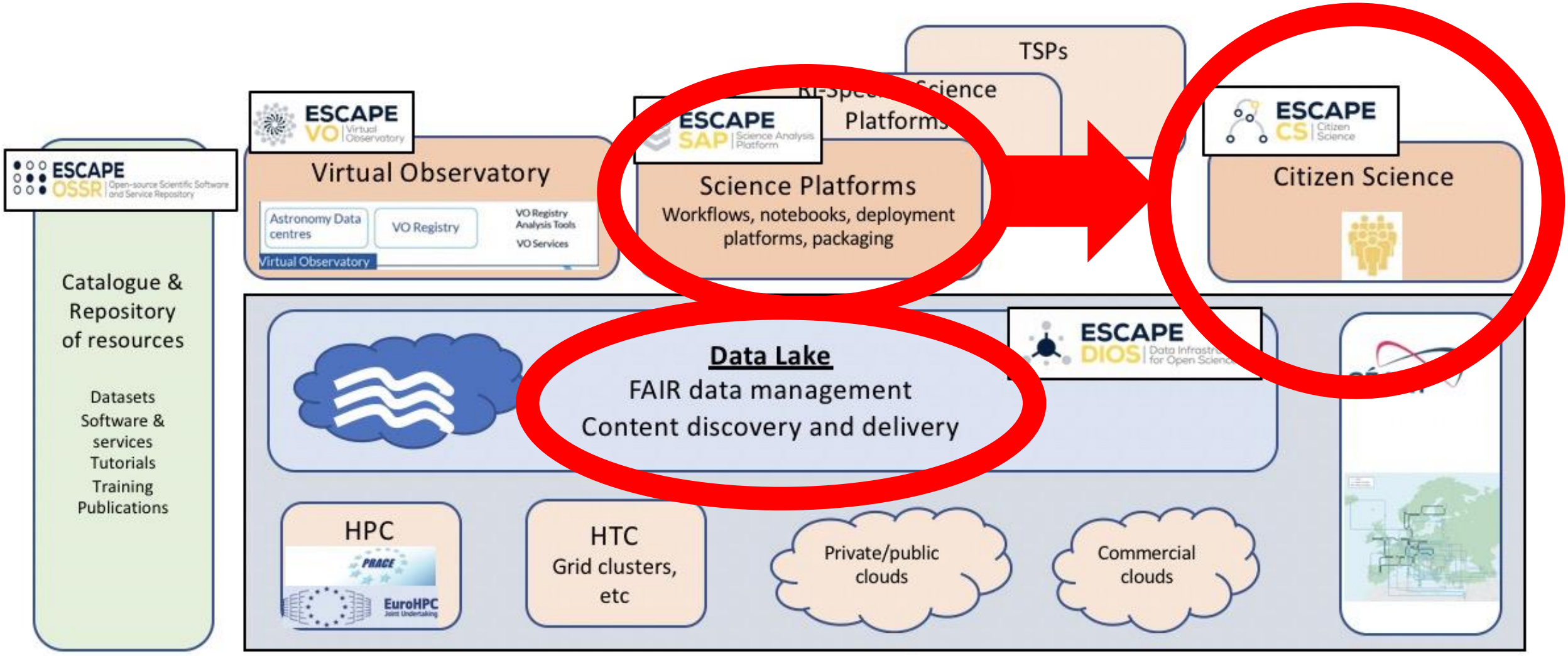

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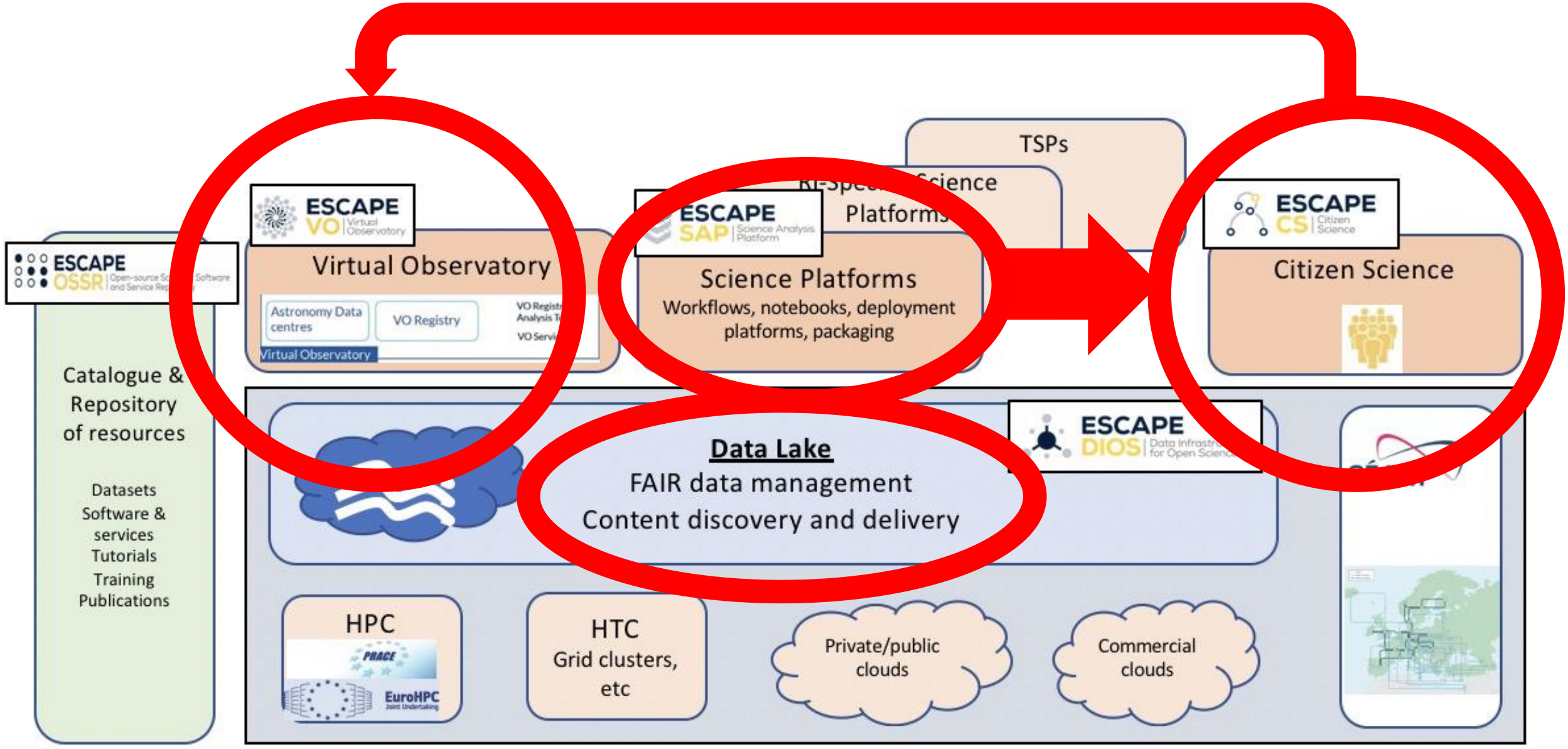

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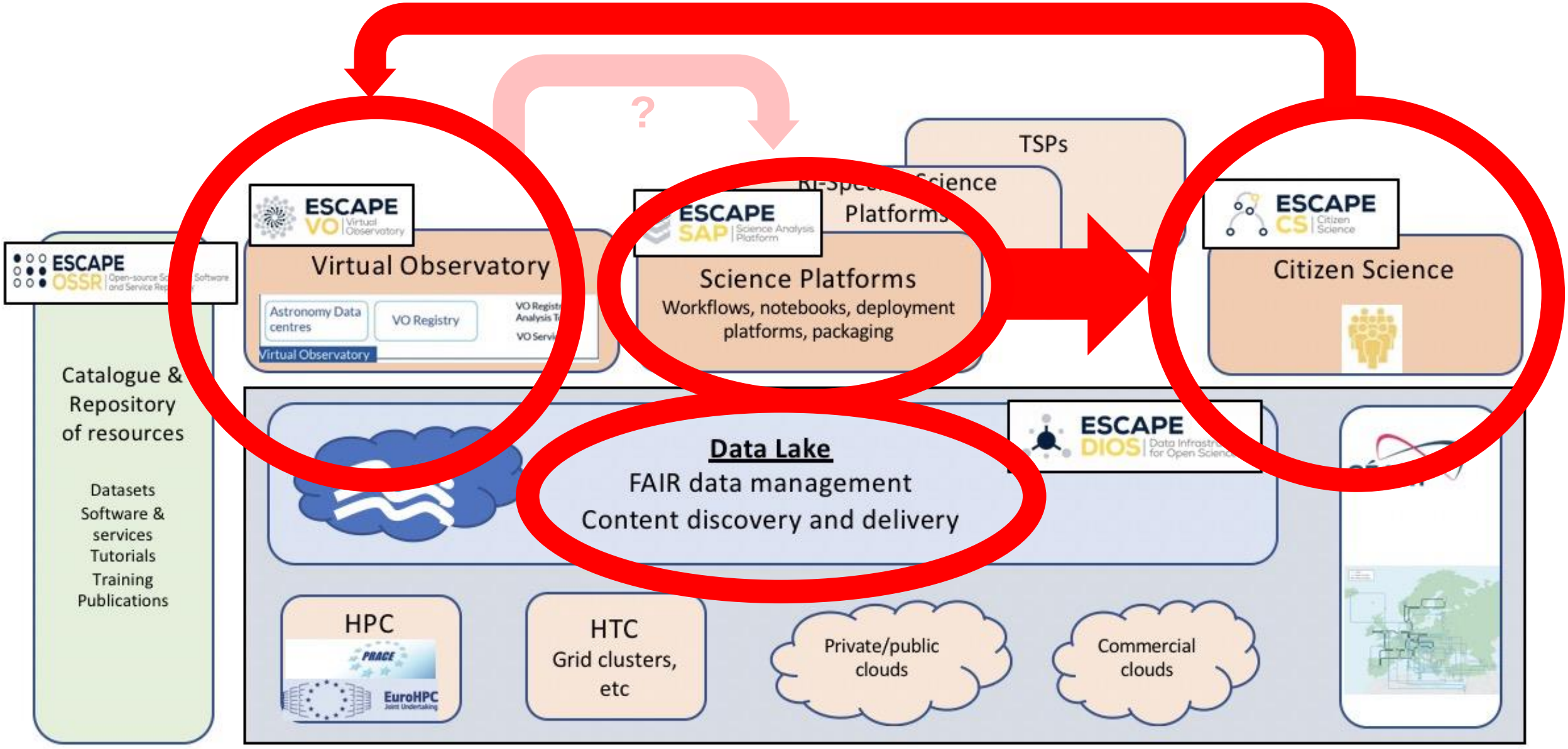

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ESCAPE Citizen Science Roadmap:

- Citizen Science Demonstrators:
  - Open the science related ESFRIs (and their pathfinders/precursors) to the general public by creating, managing and operating a harmonised suite of mass participation experiments for these facilities
  - Develop/adapt machine-learning tools for deciding when subjects are well characterised and for volunteer classification reliability
  - Create embedded educational resources
  - Create online forums for two-way dialogue with professional scientists, for participant volunteers to take their interest further, improving transparency of the scientific process.

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ESCAPE Citizen Science Roadmap:

- Legacy resources:
  - Notebook and documentary materials demonstrating web-interface based and programmatic (scriptable) Zooniverse project management including project and workflow creation, subject creation and upload, adding training and feedback to subjects,
  - Notebook and documentary materials demonstrating integration with the Zooniverse's Caesar engine for advanced aggregation and efficient subject retirement.
  - Notebook demonstrating how to integrate Zooniverse projects with existing machine learning frameworks and combine volunteer classifications with machine learning predictions.
  - Notebook and documentary materials demonstrating how to set up an active learning framework to continuously train machine learning models using volunteer classifications of optimally selected subjects.

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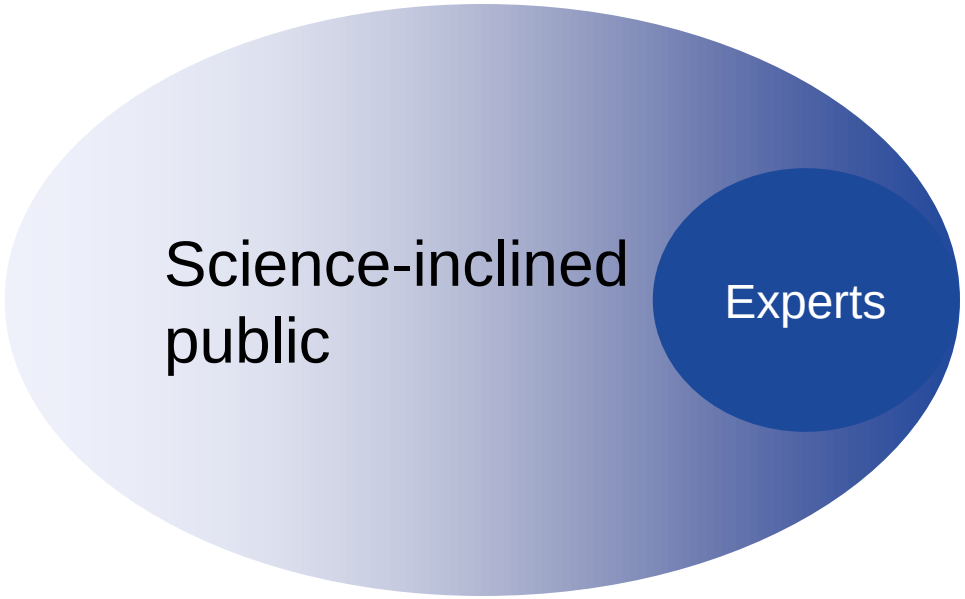

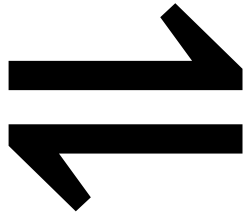

EUROPEAN OPEN SCIENCE CLOUD

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- KM3NeT:
  - REINFORCE project, Gwenhaël de Wasseige
- SKA: Pathfinder LOFAR:
  - Radio Galaxy Zoo LOFAR, Martin Hardcastle
- Vera Rubin LSST:
  - Precursor Subaru HSC: Galaxy Zoo Comic Dawn, James Pearson
  - Precursor SuperWASP: SuperWASP Black Hole Hunters, Hugh Dickinson
  - Precursor SDSS: Galaxy Zoo Clump Scout, Hugh Dickinson
- Managing citizen science from ESAP:
  - Hugh Dickinson and James Pearson

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Knitting Patterns in Domestic Magazines

African Indigenous Knowledge (AIK) for Resilient Food Systems

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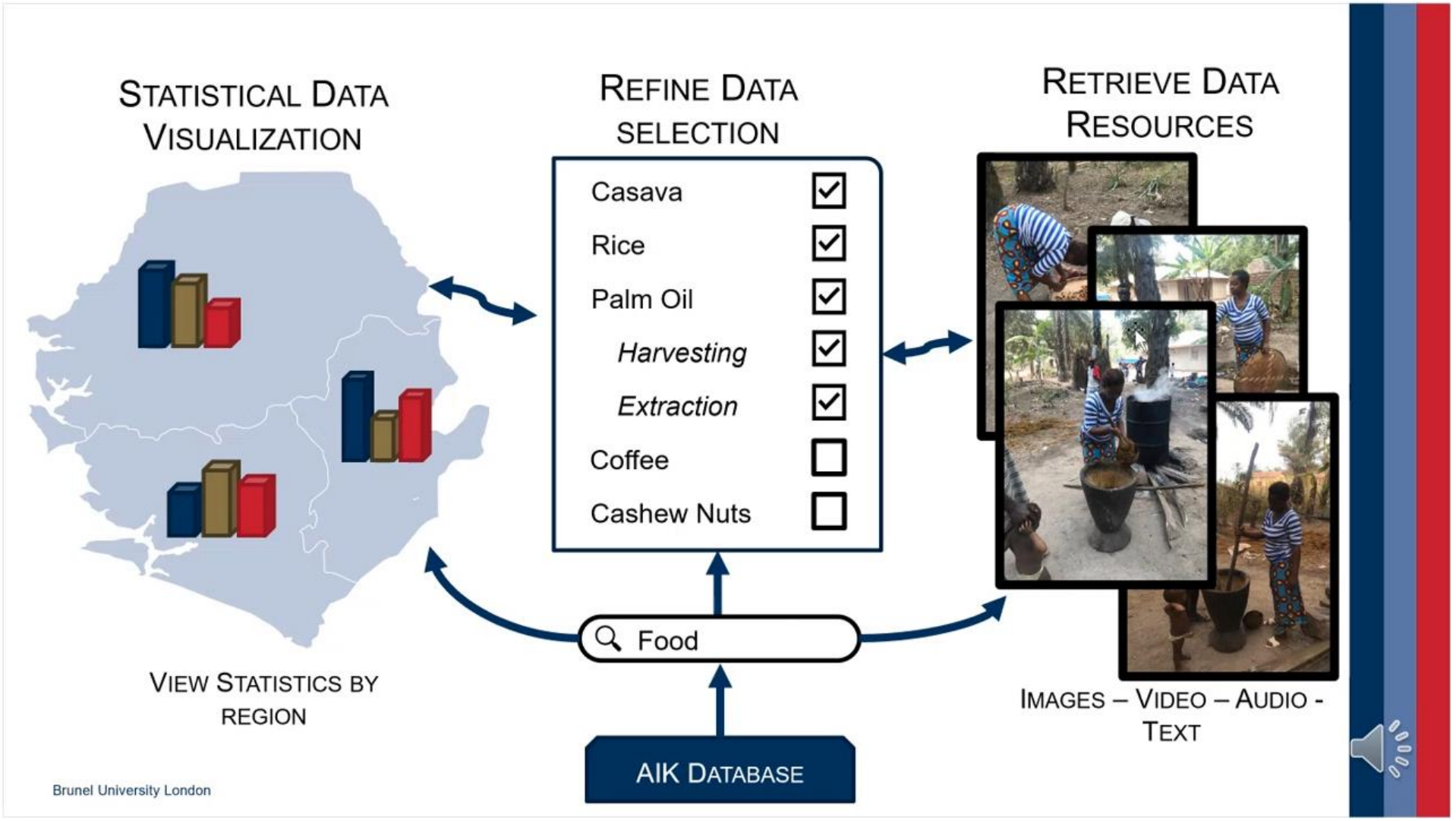
African Indigenous Knowledge (AIK)



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Knitting Patterns in Domestic Magazines

Domestic magazines present researchers with a challenge!

How do we collect and analyse data from archives too big for one person to read/process in their entirety?

Digitisation and digital reading methods support new approaches to addressing this challenge, e.g. keyword searches – but these are not suitable for domestic magazines.

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Knitting Patterns in Domestic Magazines

Four Colour Favourite

Enchanting in pastel shades, this attractive little cardigan will fit a two-to-three-year-old

MATERIALS : Of Sirdar Majestic Wool, 3-ply, allow 2 ozs. in white and 1 oz. each of green, rose-pink and blue ; 1 pair each of No. 10 and No. 11 knitting needles ; 4 buttons.

Measurements : To fit 22-23 inch chest size ; length from shoulder, 12½ inches ; sleeve seam, 8½ inches.

Abbreviations : K., knit ; p., purl ; st., stitch ; sts., stitches ; rep., repeat ; inc., increase (by working twice into same st.) ; dec., decrease (by taking 2 sts. tog.) ; W, white ; G, green ; R, rose ; B, blue.

THE BACK

RIGHT FRONT

LEFT FRONT

THE SLEEVES (both alike)

TO COMPLETE

Completed item

Materials

Title

The information needed to answer the questions can be found in these boxes.

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With thanks to: Hugh Dickinson, James Pearson, Rita Meneses, Luigi Colucci, Maud Coppel

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Deep Sea Explorers

Paschal Coyle and Gwenhaël de Wasseige
On behalf of WP4

https://www.zooniverse.org/projects/reinforce/deep-sea-explorers

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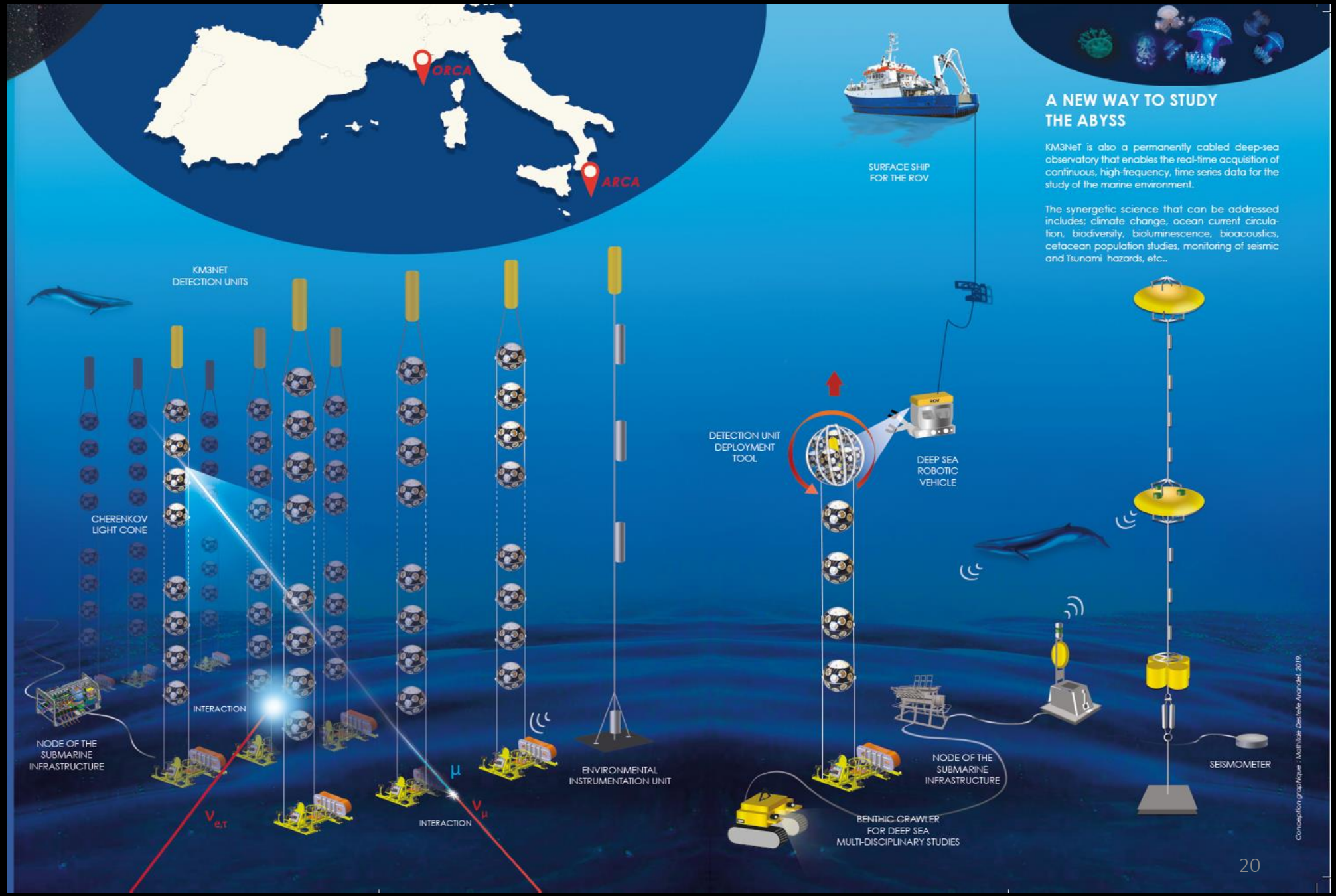
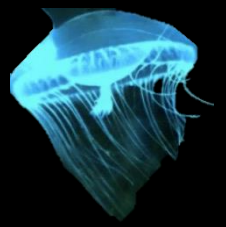
KM3NeT Neutrino Telescope



In REINFORCE, we hunt for what *is not* a neutrino

2 different workflows:

Bioluminescence



Light curves

Bioacoustics

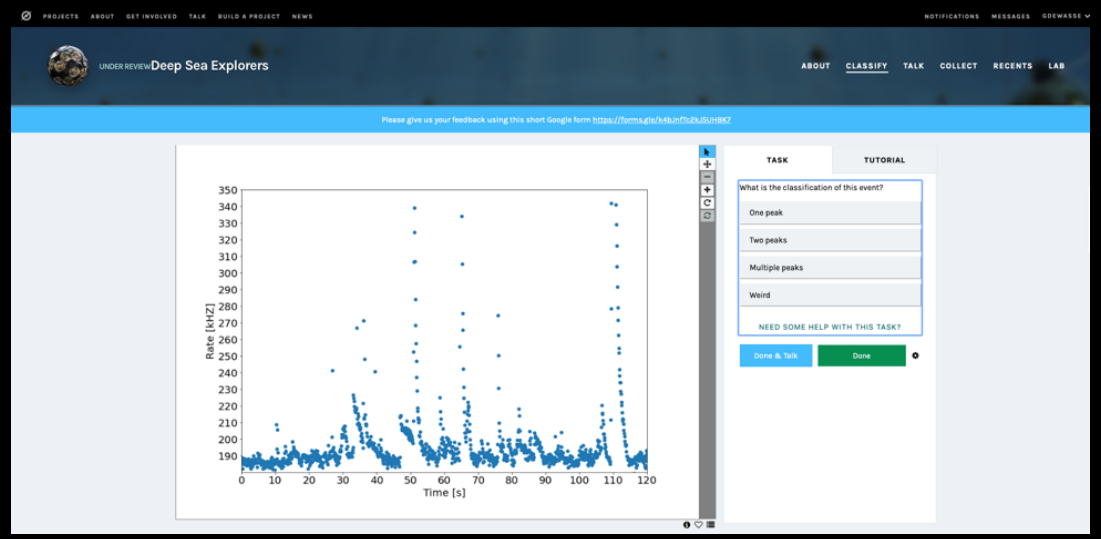
Acoustic time/frequency spectrograms

classify the characteristic emission patterns and their variations

In REINFORCE, we hunt for what *is not* a neutrino

2 different workflows:

Bioluminescence



Bioacoustics

classify the characteristic emission patterns and their variations

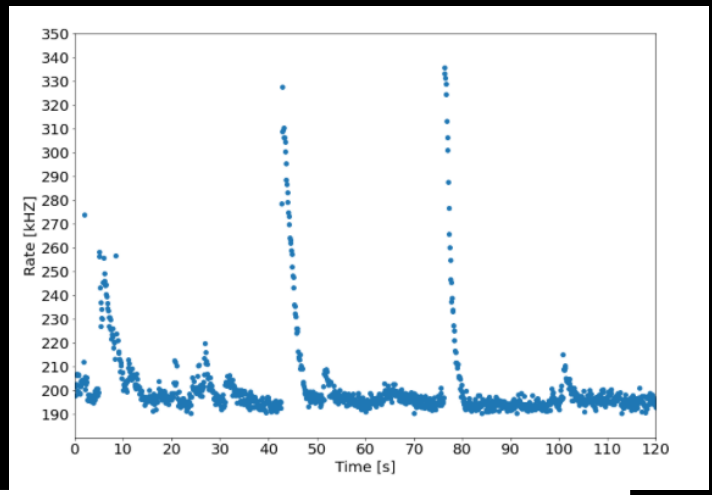
A few facts

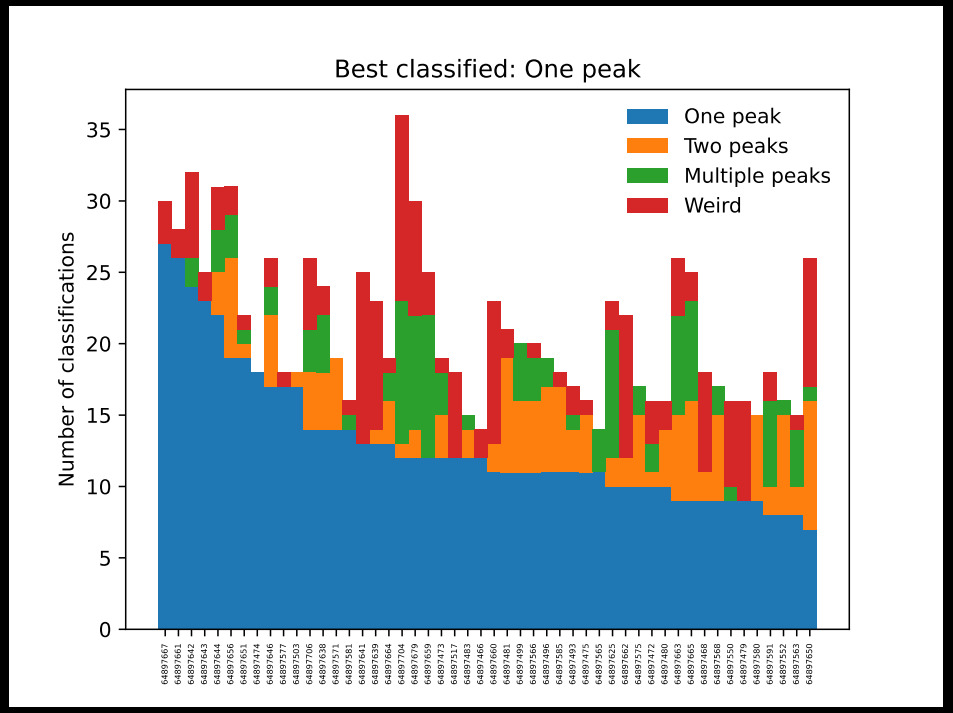
Beta test by the Zooniverse community	Official launch Phase 1	Phase 2	Last deliverable
- Several comments on the demonstrator, especially on the 'About' pages and tutorial - End of Rémy Le Breton's contract (permanent position at CEA) - Start of Gwen at UCLouvain as academic	1 month after: - 15215 classifications of 577 subjects by 752 classifiers - Mean number of classifications per user: 20.23 - Project 100% complete	- New events added to both workflows - Beginning of Phase 2 - First results shared with CS - Outreach activities at UCLouvain - Start of Enzo Oukacha (APC)	- Measure of the impact of Citizen Science for KM3NeT data classification - Unretirement of events to get more classifications in the biolum. workflow - End of Enzo's contract

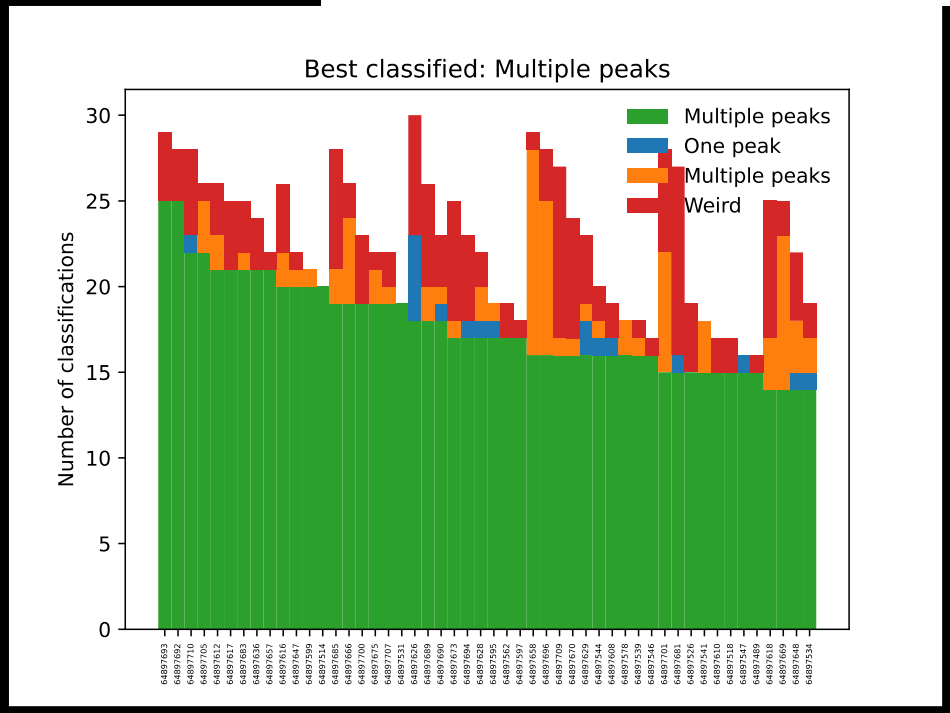
Bioluminescence for illustration

Results Phase 1

- Some events clearly identified as belonging to one of the four categories available to volunteers on Zooniverse
- Some events not classified unanimously by the participants. Example of a “Two peaks” or “Multiple peaks” event (55%-42% of the classifications in the Zooniverse demonstrator, respectively.







Fifty Phase 1 events preferentially classified as “One peak” (left) and “Multiple Peaks” (right) in the bioluminescence workflow. The x-axis indicates the arbitrary name for the events.

Bioacoustic for illustration

Results Phase 2

- The events used in Zooniverse were classified with less than 70% accuracy by a Convolutional Neural Network (CNN) trained on data from hydrophones located at the surface.

- Only the events classified in Zooniverse by at least two different participants and with an accuracy of at least 65% used in the validation and test sets to retrain the CNN

- The precision for each species (90% and 100%) should be compared to the less than 70% previously obtained for the same events without the contribution of citizen scientists.

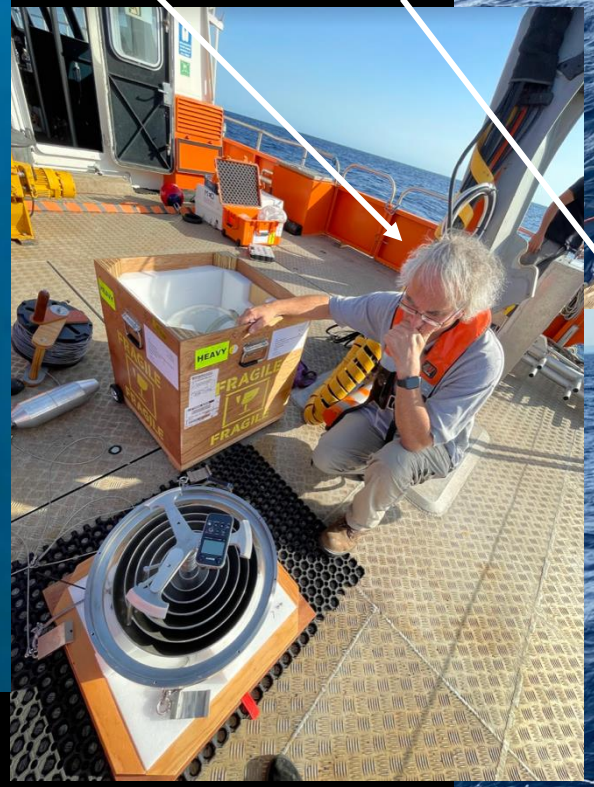
Bathysphere deployment

Gwen

Bathysphere

Paschal

Donald



http://www.donaldfortescue.com/projects#/bathysphere/

- Fall 2022: Exhibition at Center for Crafts, Asheville NC

- Spring 2023: Exhibition in Europe

https://www.centerforcraft.org/search?query=De+wasseige

http://www.donaldfortescue.com/projects#/bathysphere/

Down to 300 m!

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Thank you

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Radio Galaxy Zoo LOFAR: Citizen Science with an SKA precursor

Martin Hardcastle
University of Hertfordshire, UK

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LOFAR introduction

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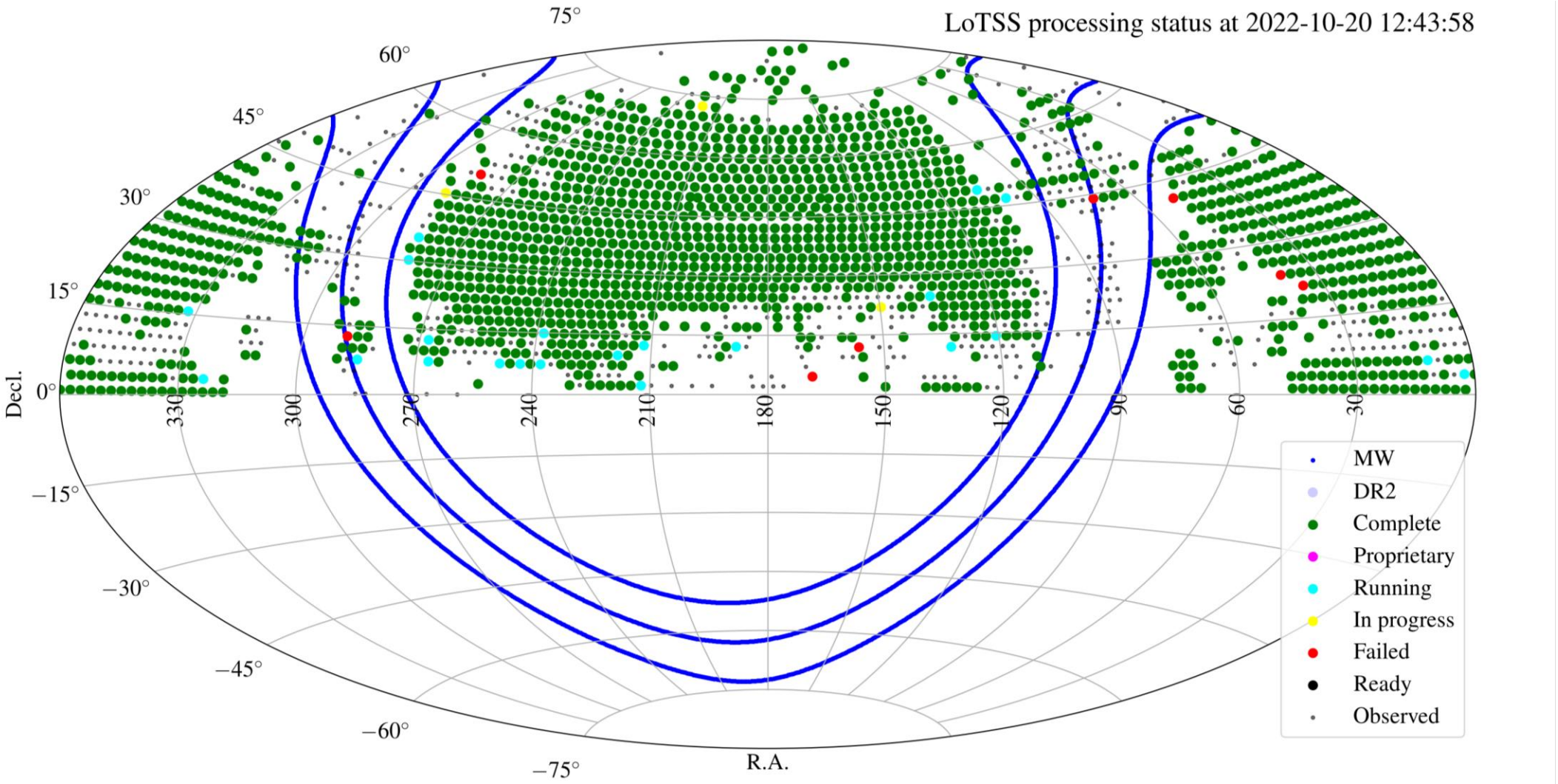
LoTSS introduction: sky coverage



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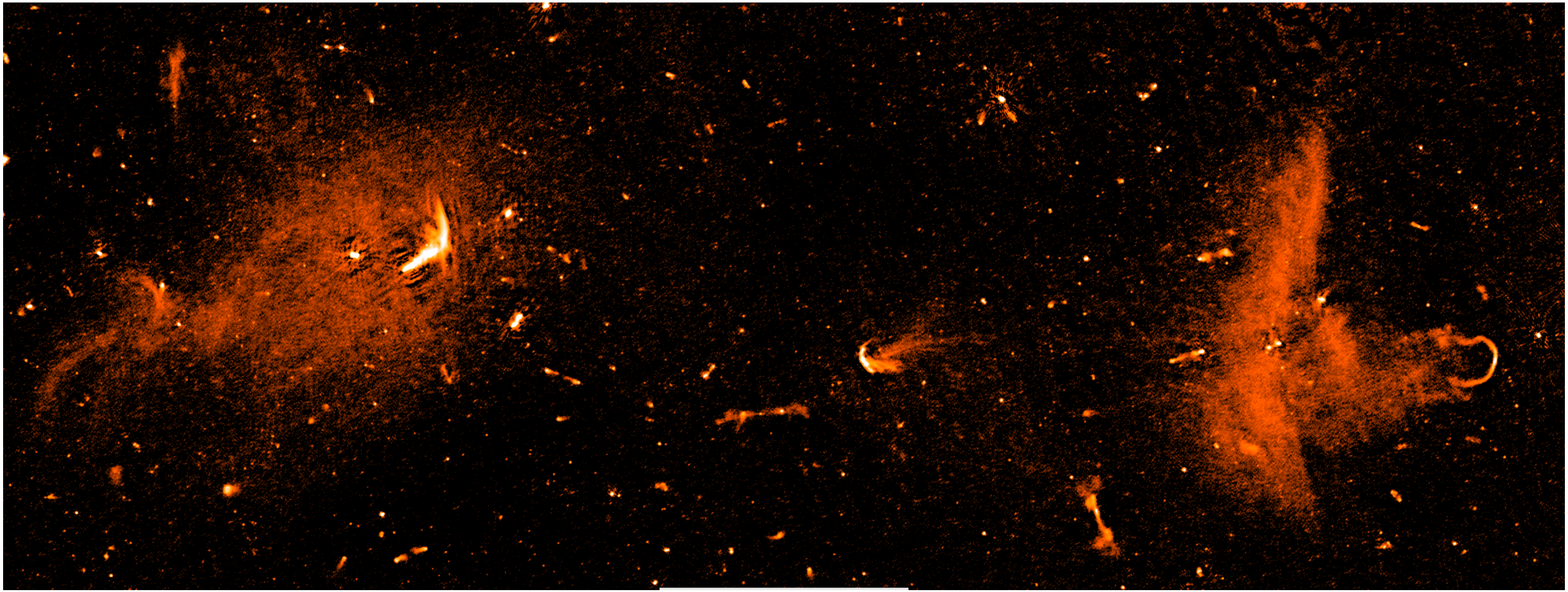
LoTSS introduction: complexity of radio sky



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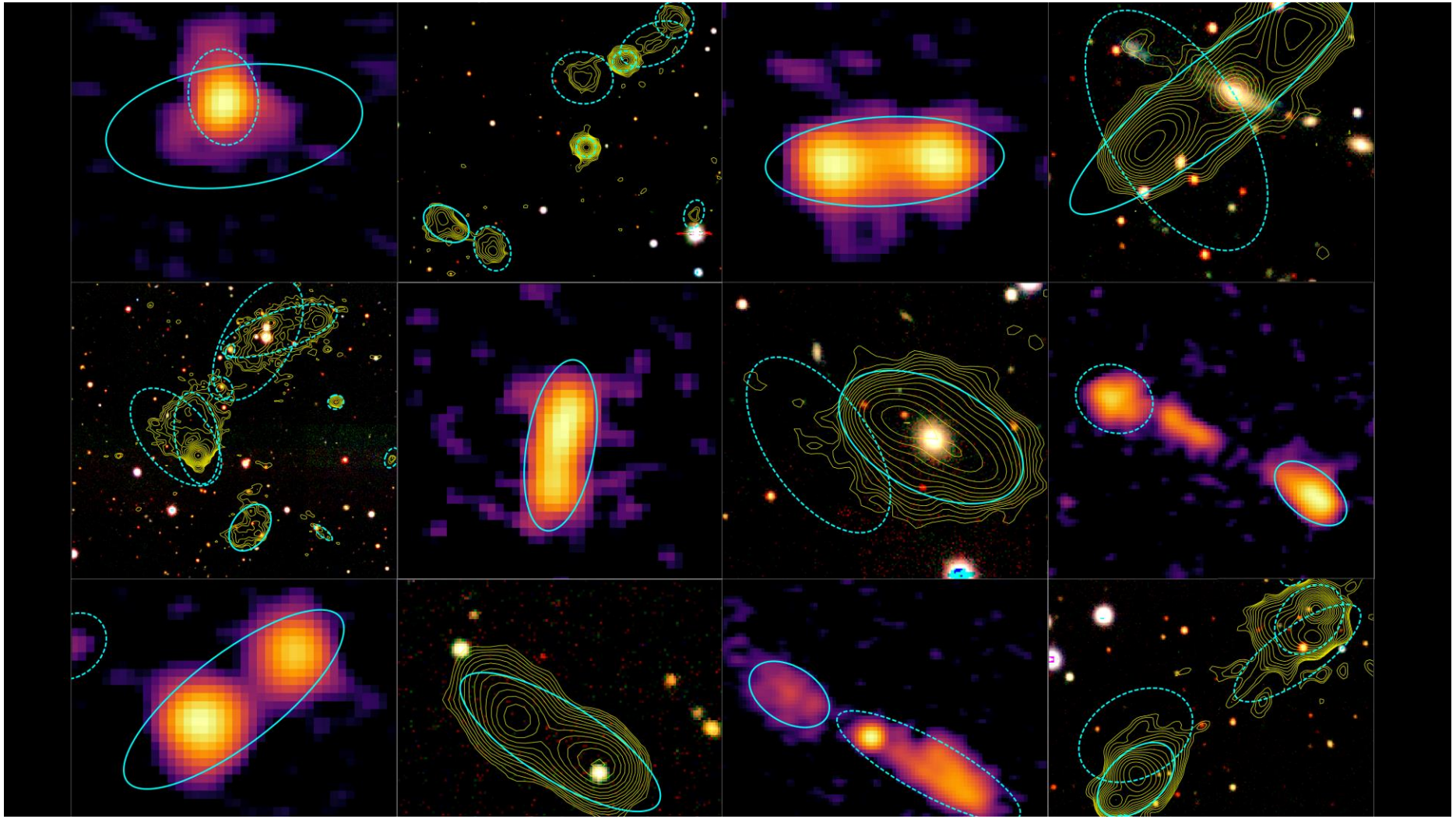
The optical ID problem



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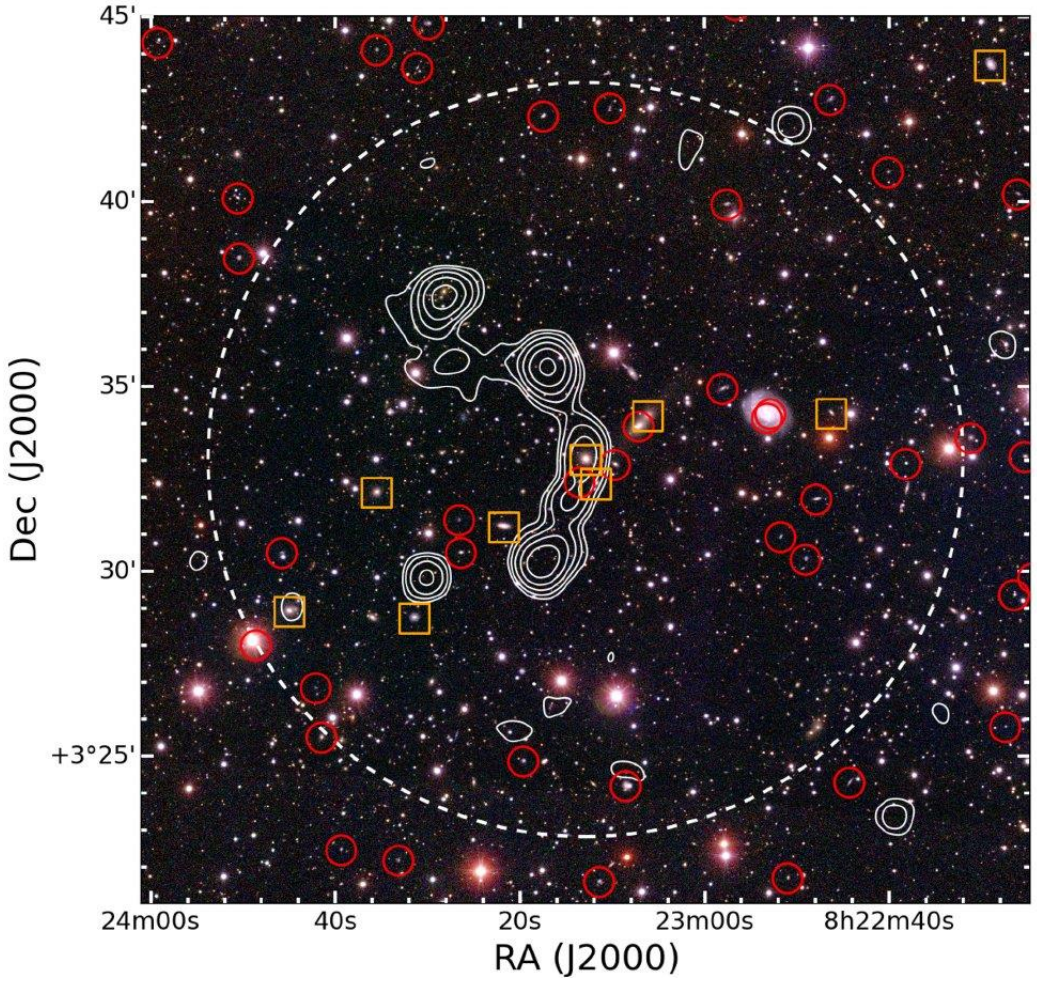
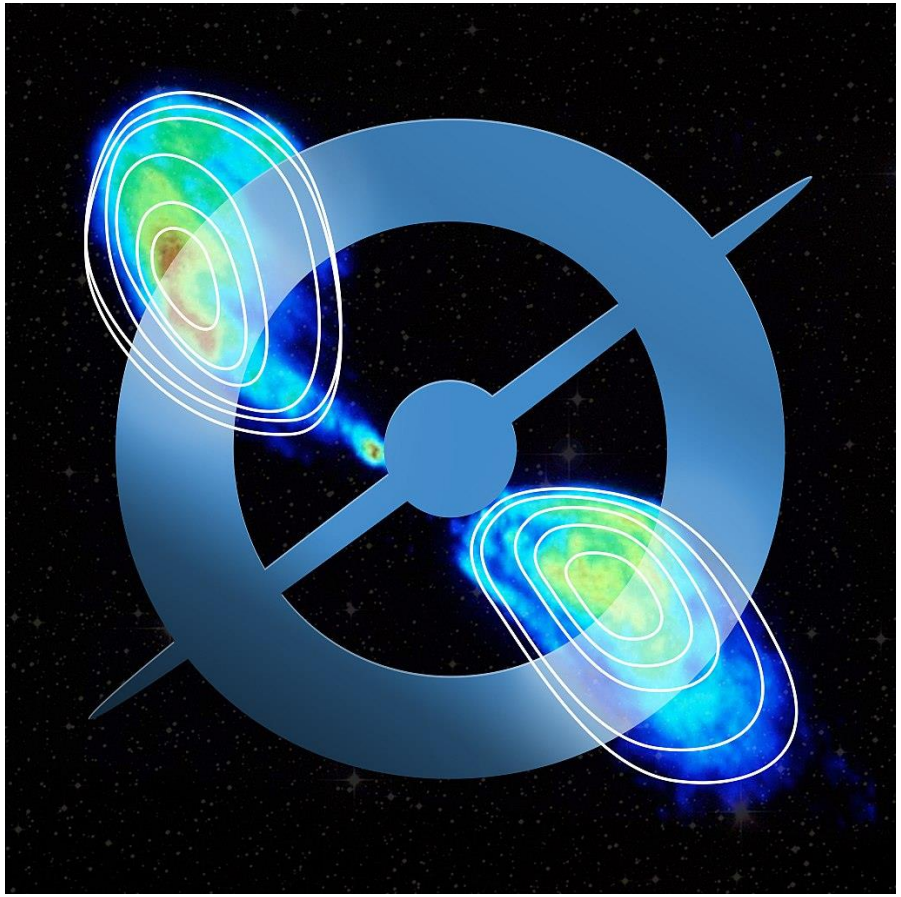
Radio Galaxy Zoo concept





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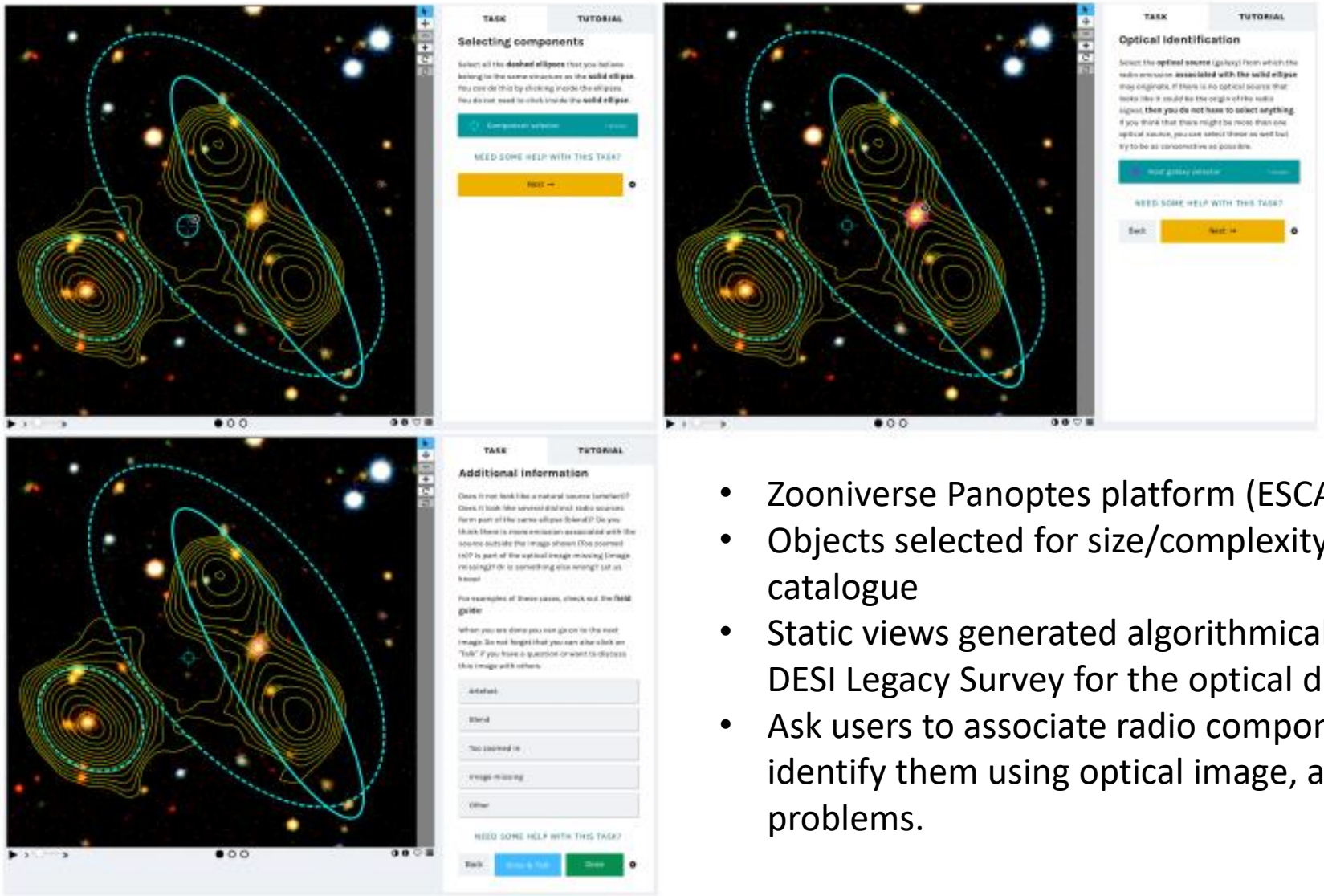
Radio Galaxy Zoo: LOFAR



- Zooniverse Panoptes platform (ESCAPE support)
- Objects selected for size/complexity from the radio catalogue
- Static views generated algorithmically using DESI Legacy Survey for the optical data
- Ask users to associate radio components, optically identify them using optical image, and report any problems.

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RGZ-LOFAR: Statistics and Outcomes

- 11,106 volunteers
- 878,148 classifications
- 2.5 year project duration
- 174,799 subjects inspected
- 46,208 optical IDs
- Input into main optical IDs paper with 3,500,000 optical IDs
- Vast range of science enabled…

Astronomy & Astrophysics manuscript no. output
October 20, 2022

The LOFAR Two-Metre Sky Survey (LoTSS)

VI. Optical identifications for the second data release

M.J. Hardcastle[1]⋆ and key LoTSS contributors, other LoTSS contributors, citizen scientists

Centre for Astrophysics Research, Department of Physics, Astronomy and Mathematics, University of Hertfordshire, College Lane, Hatfield AL10 9AB, UK

October 20, 2022

ABSTRACT

The second data release of the LOFAR Two-Metre Sky Survey (LoTSS) covers 27% of the northern sky and a much larger fraction of the extragalactic sky with $|b| > 10°$, with an areal coverage of 5,700 deg^2. The high resolution of LOFAR with Dutch baselines (6 arcsec) allows us to carry out optical identifications of a large fraction of the detected radio sources without further radio followup; however, the process is made more challenging by the many extended radio sources found in LOFAR images as a result of its excellent sensitivity to extended structure. In this paper we present source associations and identifications for sources in the second data release based on optical (Legacy Survey) and near-infrared (*WISE*) data, using a combination of a maximum-likelihood cross-match method developed for our first data release, our citizen science project Radio Galaxy Zoo (LOFAR), and new approaches to algorithmic optical identification, together with extensive visual inspection. We also present spectroscopic or photometric redshifts for a large fraction of the optical identifications. In total x,xxx,xxx radio sources lie in the area with good optical data, of which xx% have an optical or IR identification and xx% have a good redshift estimate. We investigate the quality of the dataset by (doing some early science).

Key words. galaxies: jets – galaxies: active – radio continuum: galaxies

1. Introduction

The LOFAR Two-Metre Sky Survey[1] (LoTSS: Shimwell et al. 2017) aims to survey the entire northern sky using the Low-Frequency Array (LOFAR: van Haarlem et al. 2013) at a central frequency of 144 MHz. When complete, the survey will provide an unrivalled resource for wide-area low-frequency selection of extragalactic samples, both of star-forming galaxies (hereafter SFG) and of radio-loud AGN (hereafter RLAGN). It will be complemented by a number of other surveys, including, within LoTSS itself, the study of a number of deep fields of particular interest, including the Lockman Hole, Boötes (Tasse et al. 2021) and ELAIS-N1 (Sabater et al. 2021) fields, but also a counterpart survey at lower LOFAR frequencies, the LOFAR LBA Sky Survey (LoLSS: de Gasperin et al. 2021). Key to the science goals of the project is accurate redshift information for the host galaxies of the radio sources. This information will be provided in part by more than one million optical spectra that will be obtained using the WEAVE (William Herschel Telescope Enhanced Area Velocity Explorer) instrument as part of the WEAVE-LOFAR project (Smith et al. 2016), and for the remaining LOFAR sources by state-of-the-art photometric redshifts (Duncan et al. 2021). Although LoTSS is currently largely generating images using only the Dutch baselines of LOFAR, with a typical resolution of 6 arcsec, a stretch goal of the project is to exploit the much higher resolution provided by the full International LOFAR Telescope (ILT), which can be ~ 0.3 arcsec at 144 MHz (Morabito et al. 2021), over large areas of the sky.

In order to exploit the full potential of deep extragalactic radio surveys, we need optical identifications, and the photometric and/or spectroscopic redshifts that they make possible. Spectroscopic followup projects such as WEAVE-LOFAR also rely where possible on accurate optical positions of target sources. Historically, radio continuum surveys have produced catalogues of radio sources for others to follow up with further radio or optical observations: for example, the highly influential revised 3CR sample of the brightest extragalactic low-frequency radio sources in the northern sky (3CRR: Laing et al. 1983), itself based on radio data taken in the 1960s (Bennett 1962; Gower et al. 1967), only received its final optical identification in 1996 (Rawlings et al. 1996). The radio survey that was the largest in terms of numbers of sources detected until very recently, the NRAO Very Large Array (VLA) Sky Survey (Condon et al. 1998), which covers the whole sky above declination −40°, has never had anything approaching a full optical identification catalogue, partly because of the lack of any appropriate counterpart optical catalogue but also because its low resolution (45 arcsec) precludes matching of the radio sources with optical data. Higher-resolution large-area surveys, such as FIRST (Becker et al. 1995) are more easily matched to optical data, but high-resolution surveys with the VLA are insensitive to large-scale structure due to a lack of short interferometric baselines, and so obtaining a catalogue that is both optically identified and flux-complete in the radio has historically involved labour-intensive combination of multiple radio catalogues with the optical data (e.g. Gendre & Wall 2008; Best & Heckman 2012).

A further complication of the process of optical identification of radio sources is due to the fact that radio structures can be physically large, with complex, resolved structure extending to much larger scales than those of the host galaxy observed in the optical. In extreme (but far from uncommon) cases, the catalogued positions of the two lobes of a double radio galaxy may

⋆ e-mail: m.j.hardcastle@herts.ac.uk
[1] See http://lofar-surveys.org/

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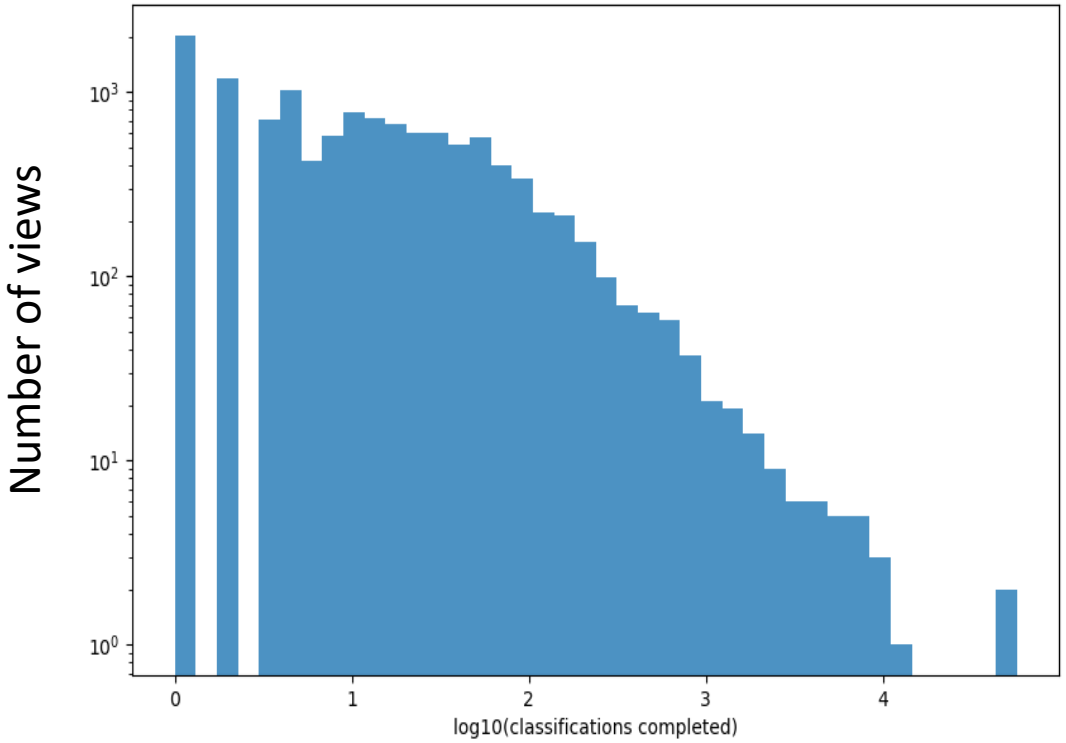
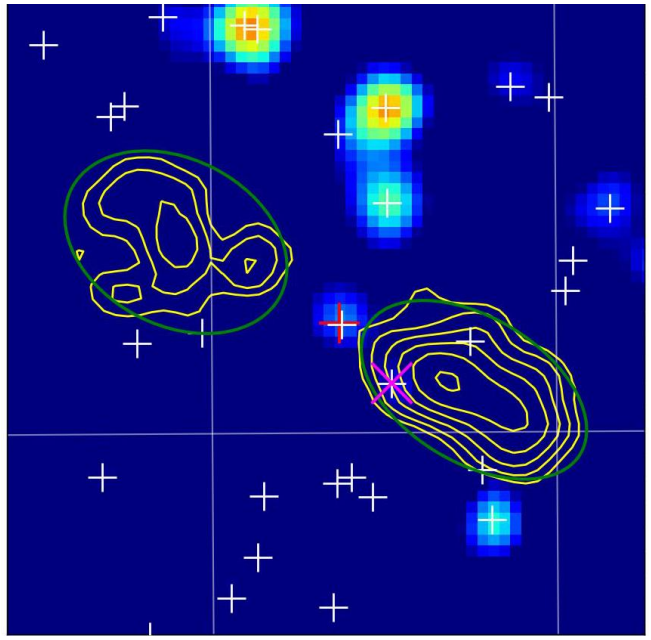
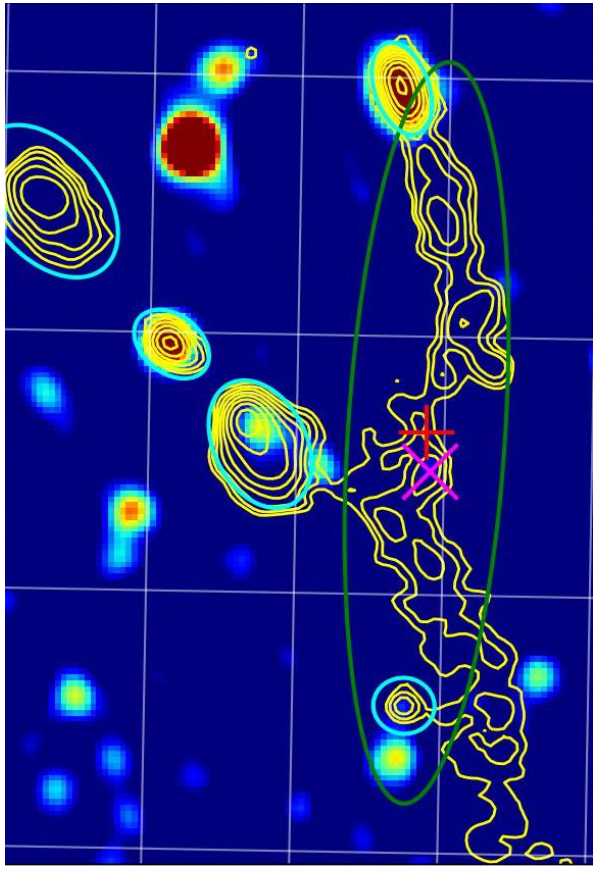
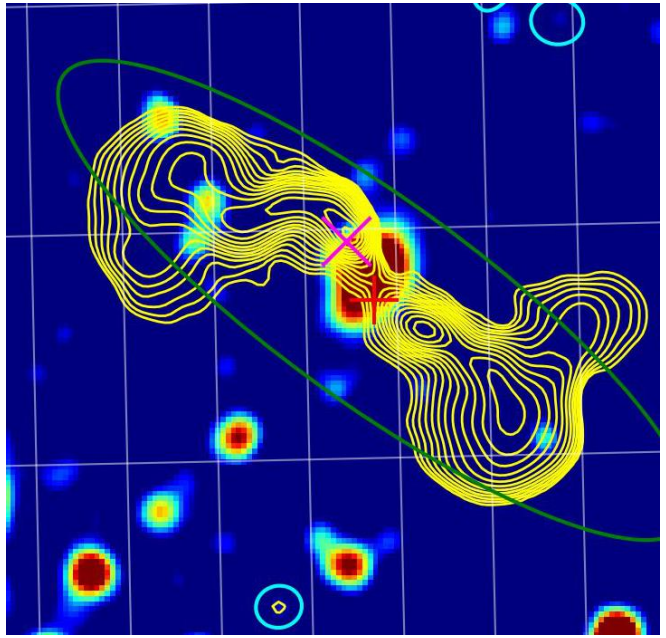
RGZ-LOFAR: Some issues









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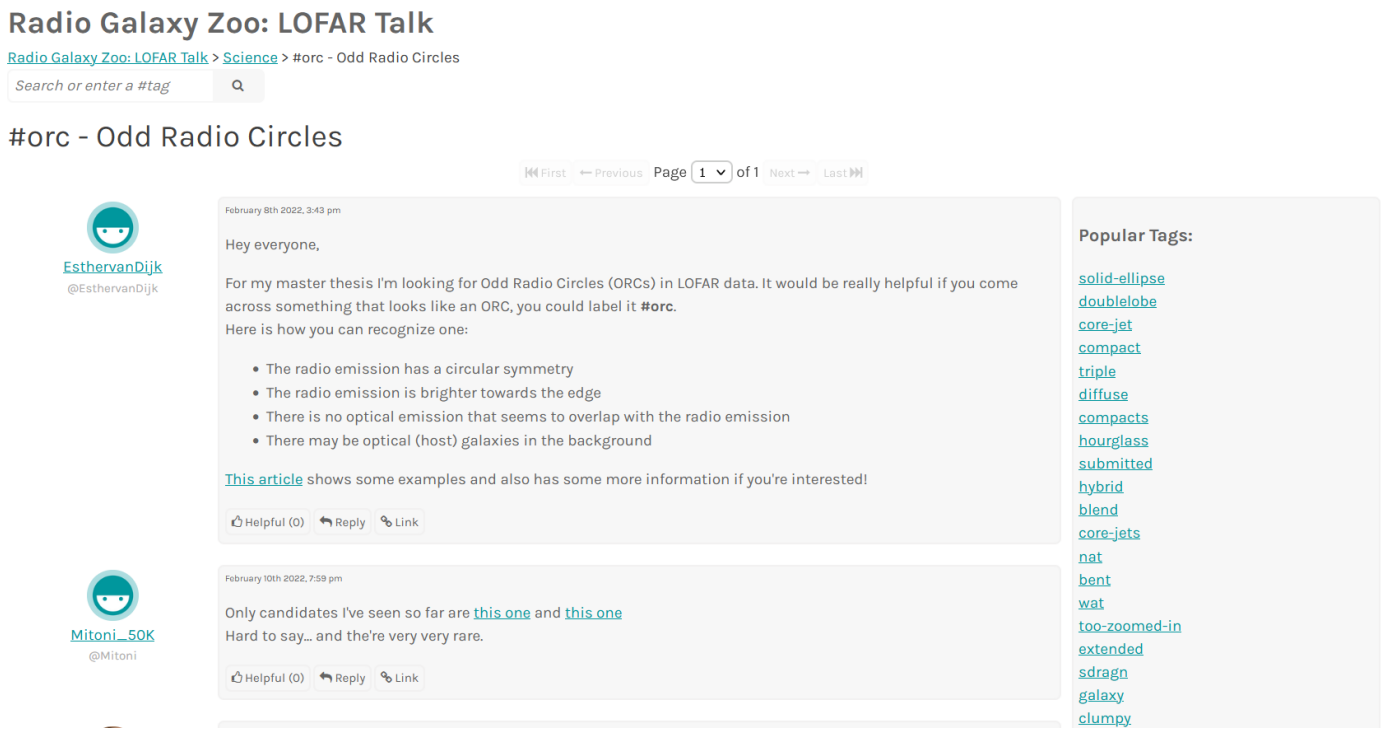
RGZ-LOFAR: Value added by citizen science

- Individual thought put into most interesting objects
- Tags, comments etc flag targets for followup
- Dialogue between citizen scientists and researchers
- Topics can be proposed and studied in real time



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Where next with SKA + LSST?

- RGZ and RGZ-LOFAR are at the limits of size
- Still issues with selecting the right objects and asking the right questions
- But clear role for citizen scientists in dealing with the most complex objects
- Improve selection – ML to the rescue?
- Genuine exploration of the data through domain-aware platform would greatly improve the citizen scientist experience

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Thanks for your attention!

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ESCAPE to the Future

25-26 October 2022

Brussels, Belgium

LSST/Vera Rubin precursor: Subaru HSC

Galaxy Zoo: Cosmic Dawn

James Pearson, Hugh Dickinson, Stephen Serjeant

Galaxy Zoo Team

ZOONIVERSE

HAWAII TWO-O

COSMIC DAWN SURVEY

The Open University

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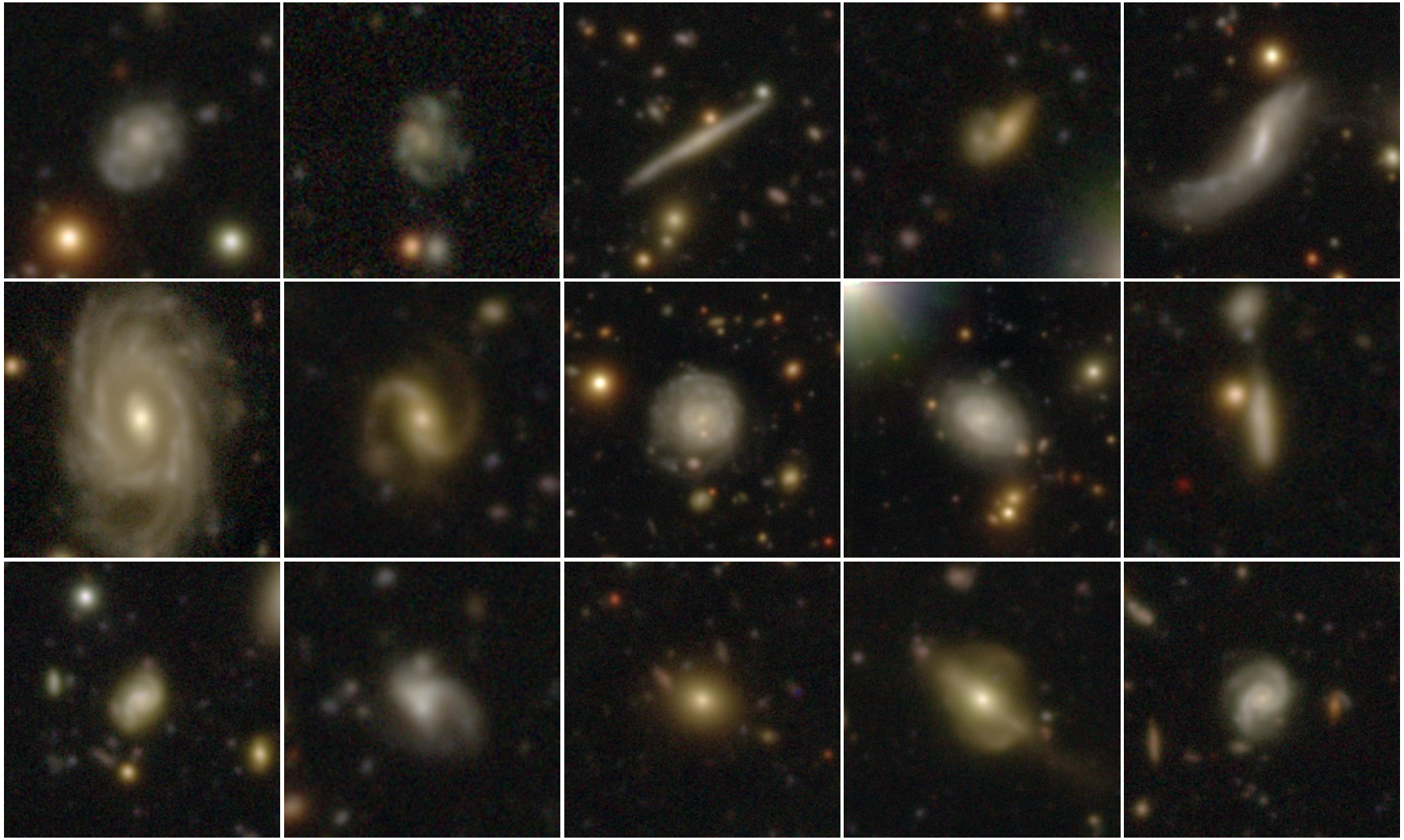
https://www.zooniverse.org/projects/zookeeper/galaxy-zoo

Galaxy Zoo



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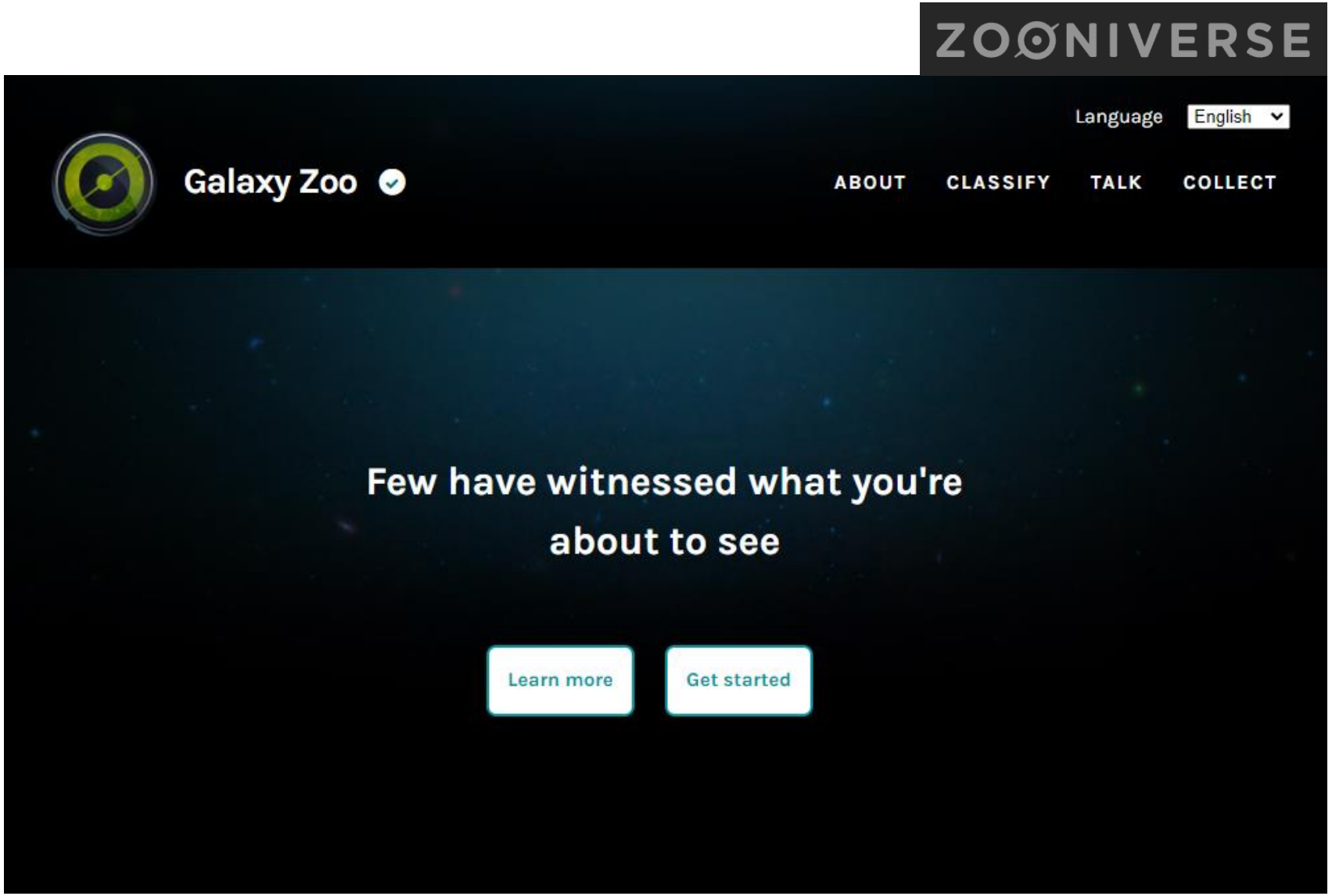

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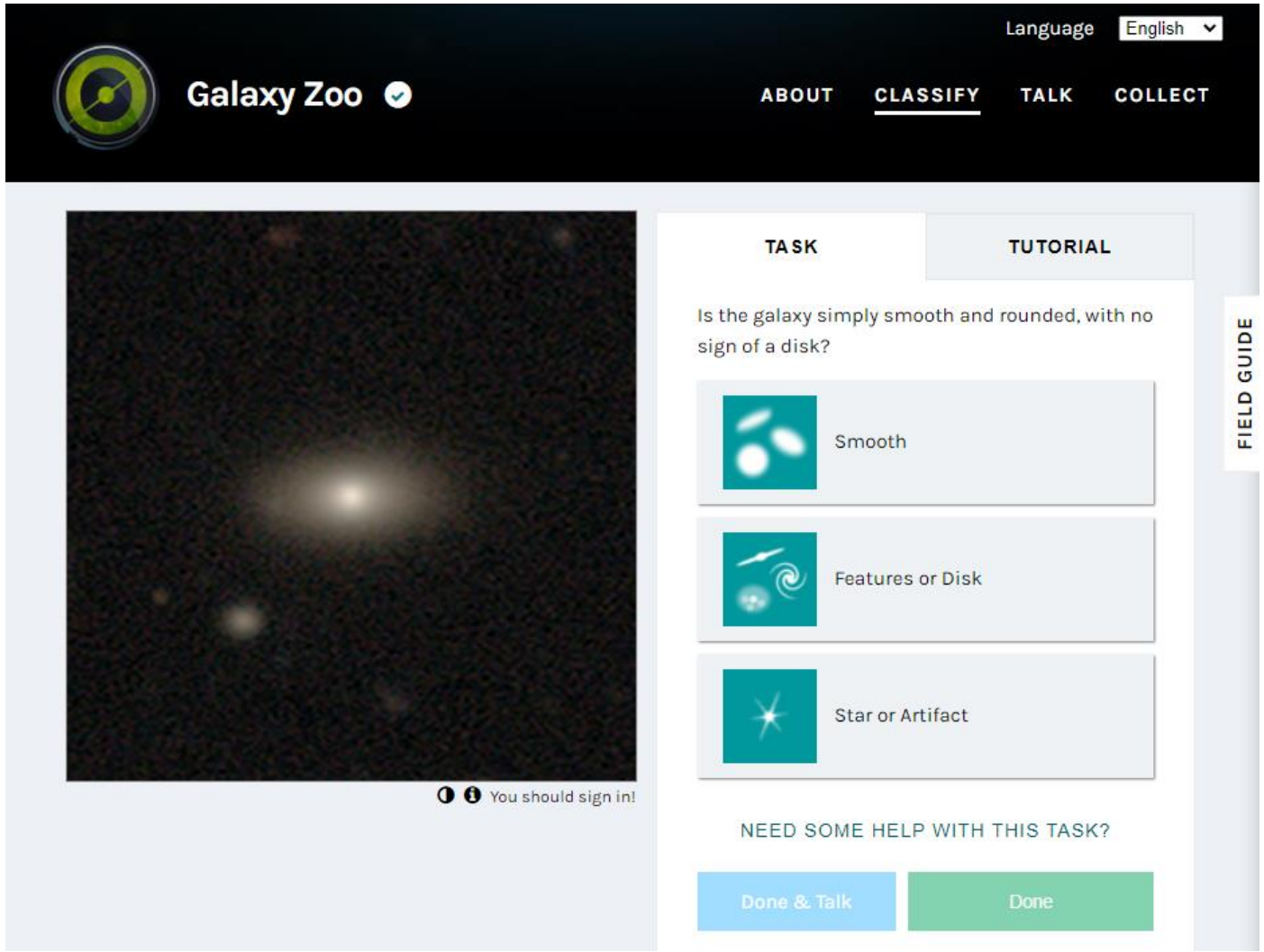

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Galaxy Zoo: Cosmic Dawn

Citizen science galaxy classification using Subaru **Hyper Suprime-Cam (HSC)** imaging from the **Hawaii Two-0 (H20) Cosmic Dawn survey.**

Cosmic Dawn

- Multi-wavelength survey of the Euclid Deep and Calibration fields – some of the darkest and most observable fields on the sky.
- Aims to understand the co-evolution of galaxies, black holes, and the dark matter haloes that host them across cosmic time.

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Galaxy Zoo: Cosmic Dawn

H20

- Ultra-deep Subaru HSC imaging of the two primary Euclid deep calibration fields, including the Euclid Deep Field North (EDF-N).
- Studying galaxy evolution out to z = 7 (<800 million years after the Big Bang).

Galaxy Zoo project

- Hundreds of thousands of H20 HSC images of the (10 sq. deg.) EDF-N.

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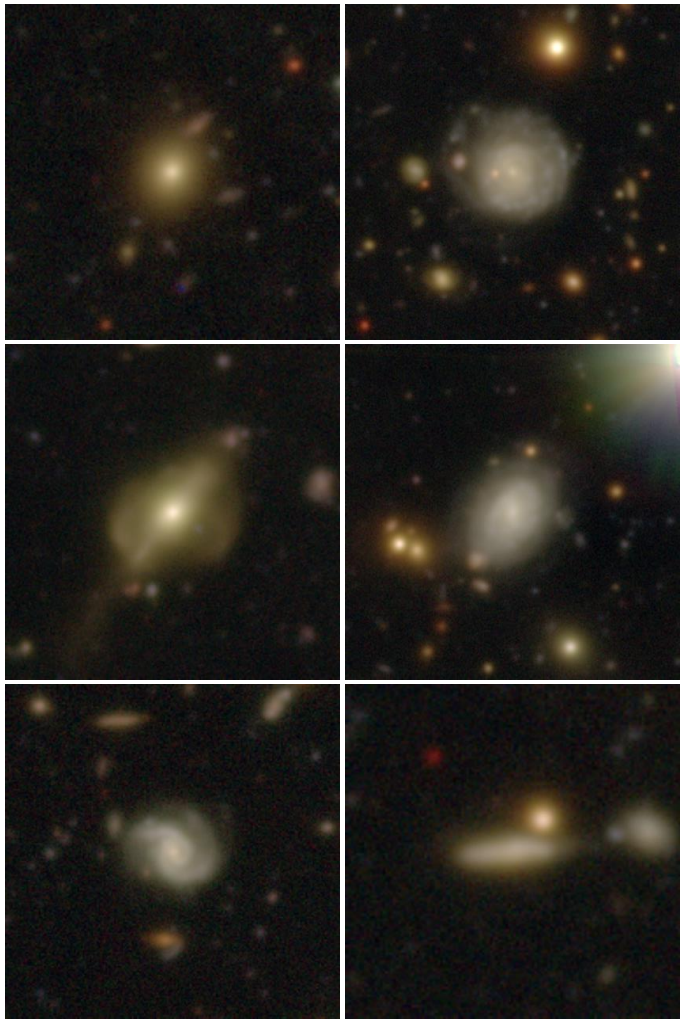
Galaxy Zoo: Cosmic Dawn



Benefits

- LSST Rubin precursor: mapping provides **multiband ground truth sets** for use in training deep learning models.
- Euclid precursor: mapping the EDF-N provides **initial classifications for rapid follow-up** of the most interesting objects.
- Higher-end resolution and deep multiband imaging for statistically studying both **higher redshift sources** and **low surface brightness features.**
- Expands the lists of interesting objects, including those from **serendipitous discovery**.

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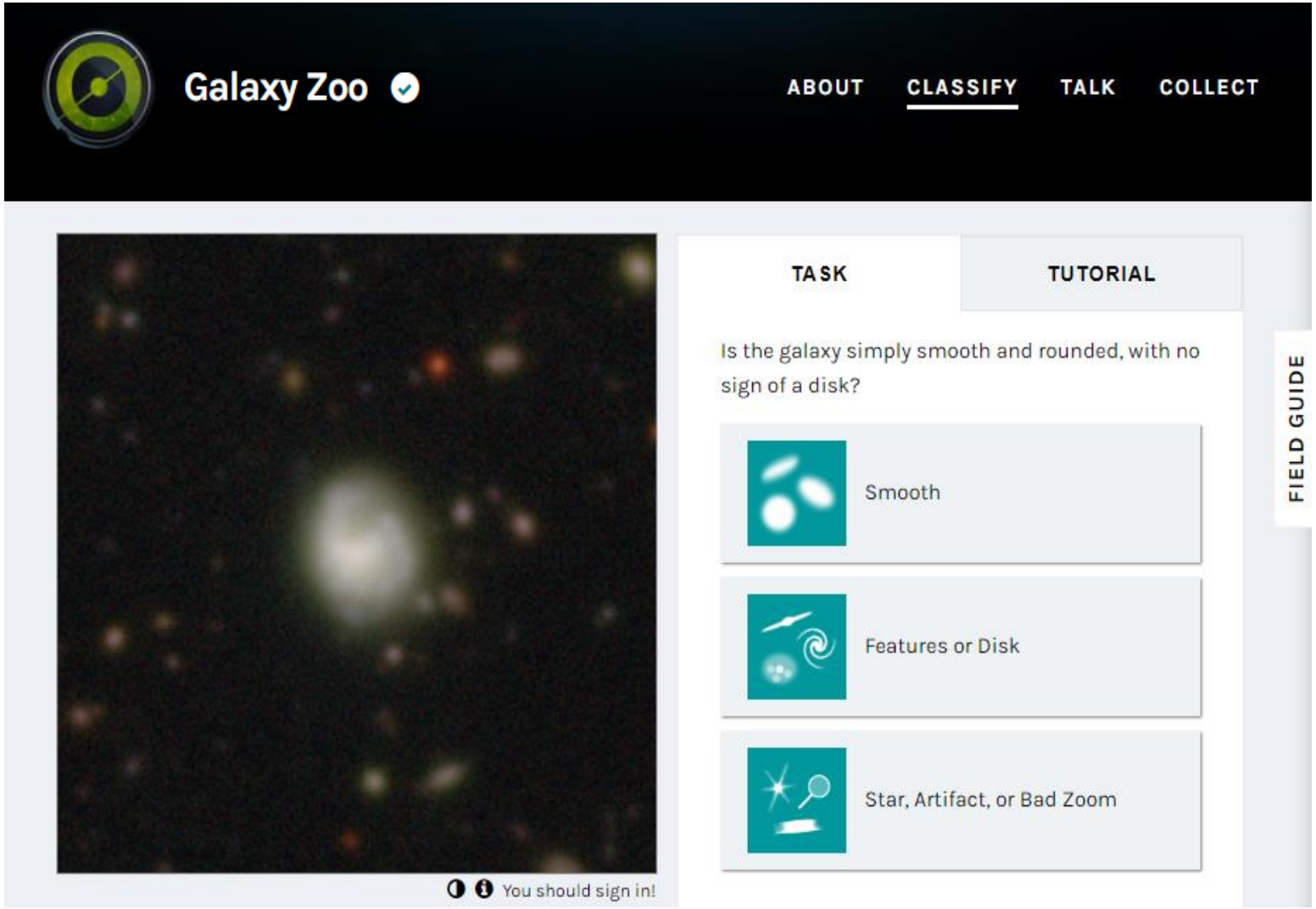

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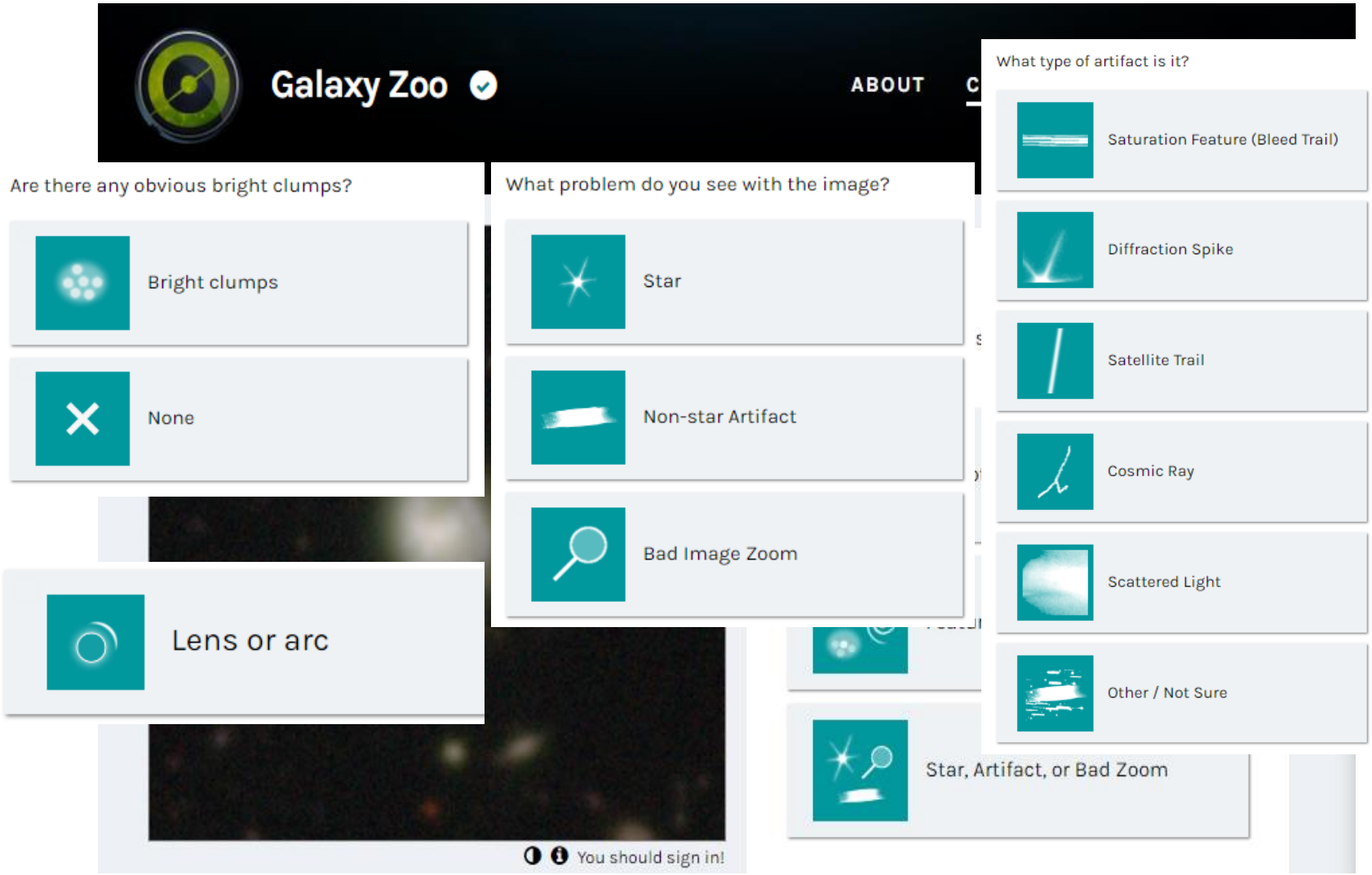

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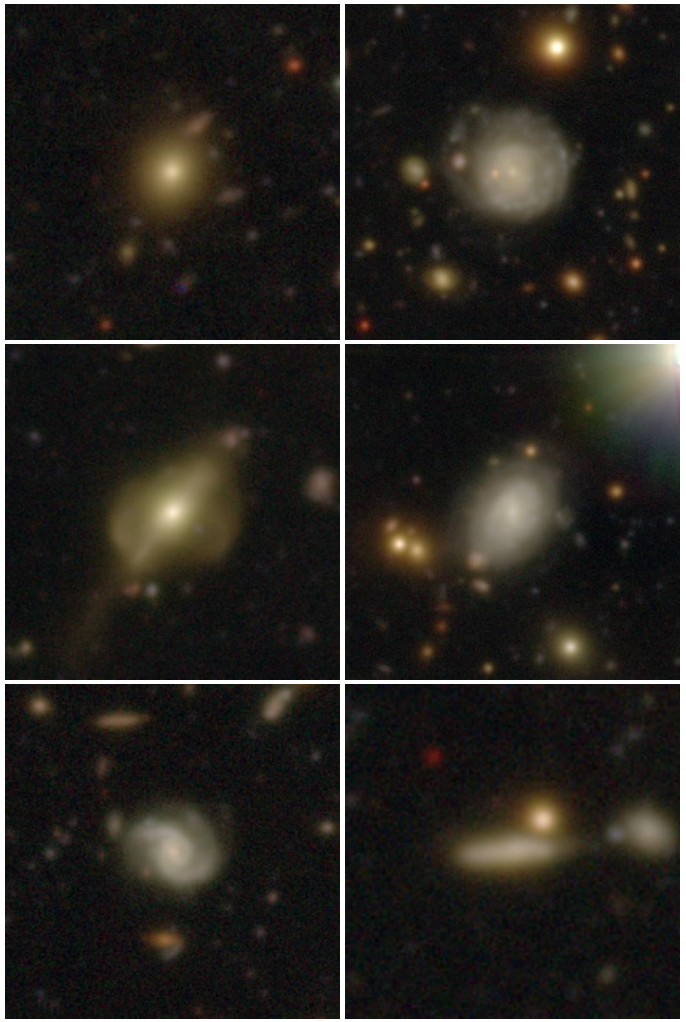
Galaxy Zoo: Cosmic Dawn

Potential Publications

- General data release paper
- Strong gravitational lens discoveries
- Clumpy galaxy statistics
- Low surface brightness features
- Barred galaxy discoveries and statistics
- Interesting cases of utilising machine learning (Zoobot)
- Galaxy mergers identified by GZ, and their correlation with AKARI/Spitzer data
- Correlations between Galaxy Zoo morphology and IR luminosity



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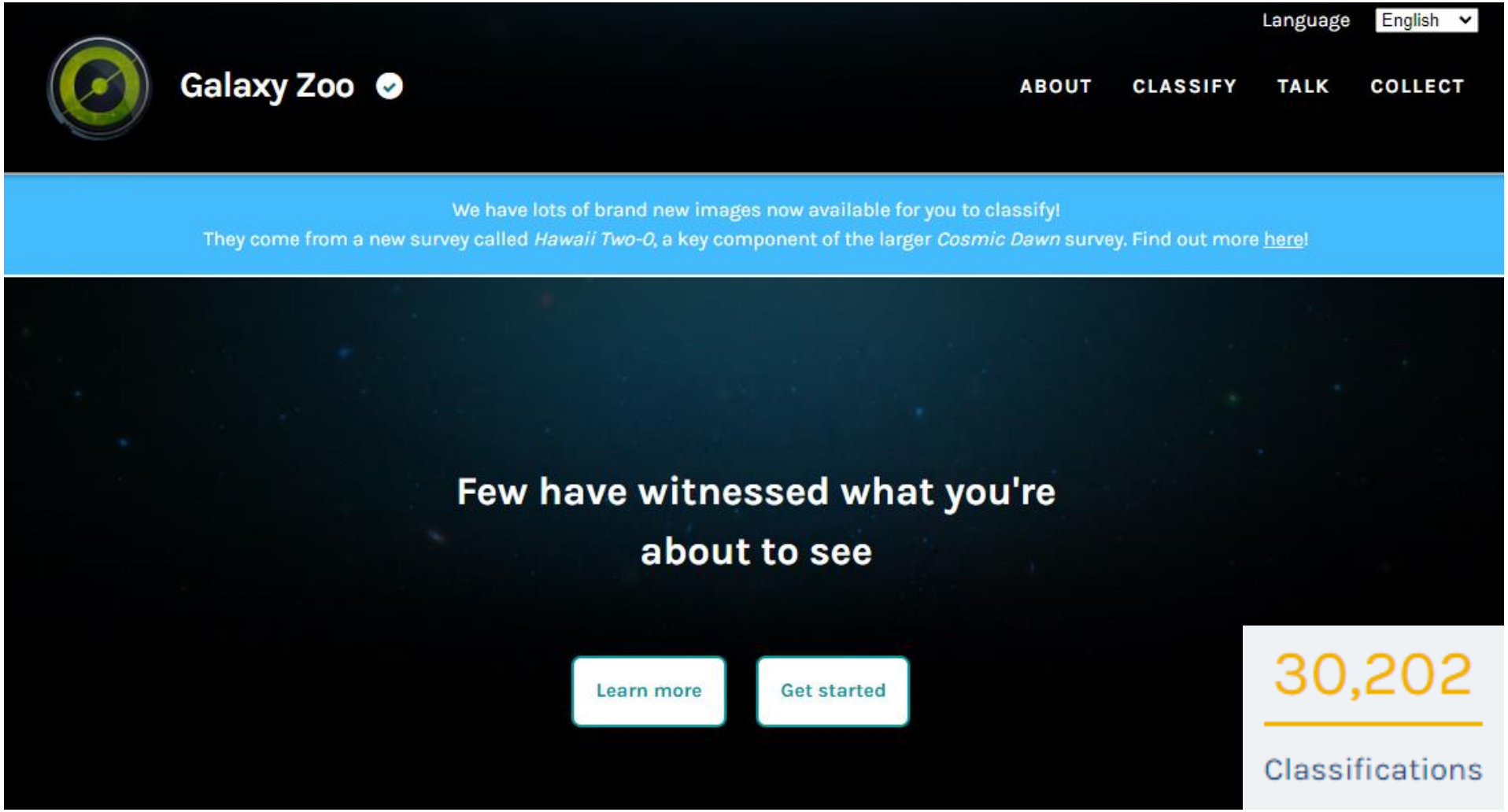
Galaxy Zoo: Cosmic Dawn



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Thanks for listening!

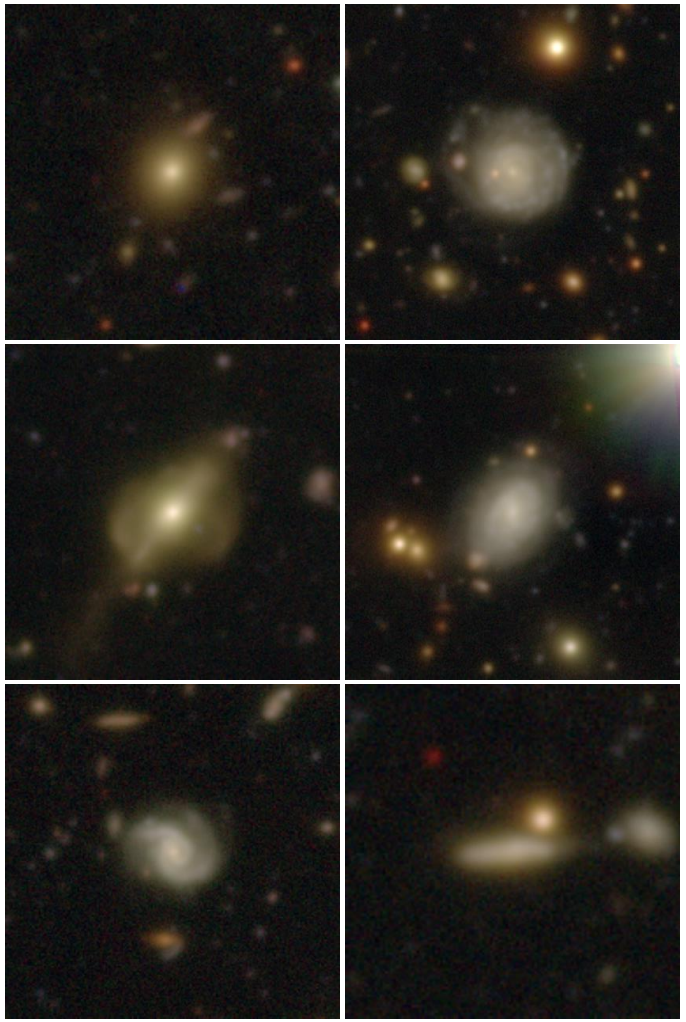
https://www.zooniverse.org/projects/zookeeper/galaxy-zoo

https://www.zooniverse.org/projects/zookeeper/galaxy-zoo

Galaxy Zoo: Cosmic Dawn

Summary

- Galaxy Zoo is the longest running Zooniverse citizen science project, classifying galaxies based on their visual morphologies.
- Galaxy Zoo: Cosmic Dawn forms its next iteration, using deep multi-band Subaru HSC imaging of the EDF-N, with data from the H20 Cosmic Dawn survey.
- Benefits include:
  - Studying higher-z sources and those with LSB features,
  - Expanding the list of interesting objects (e.g. through serendipitous discovery),
  - Mapping the EDF-N acts as a precursor for Euclid by providing initial classifications for rapid follow-up,
  - Project acts as a precursor for Rubin LSST by creating multiband ground truth sets for training deep learning models.



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Brussels, Belgium

ESCAPE Citizen Science SuperWASP: Black Hole Hunter

Hugh Dickinson – The Open University

Team: Adam McMaster, Andrew Norton, Matthew Middleton, Heidi Thiemann, Stephen Serjeant

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Searching for hidden black holes

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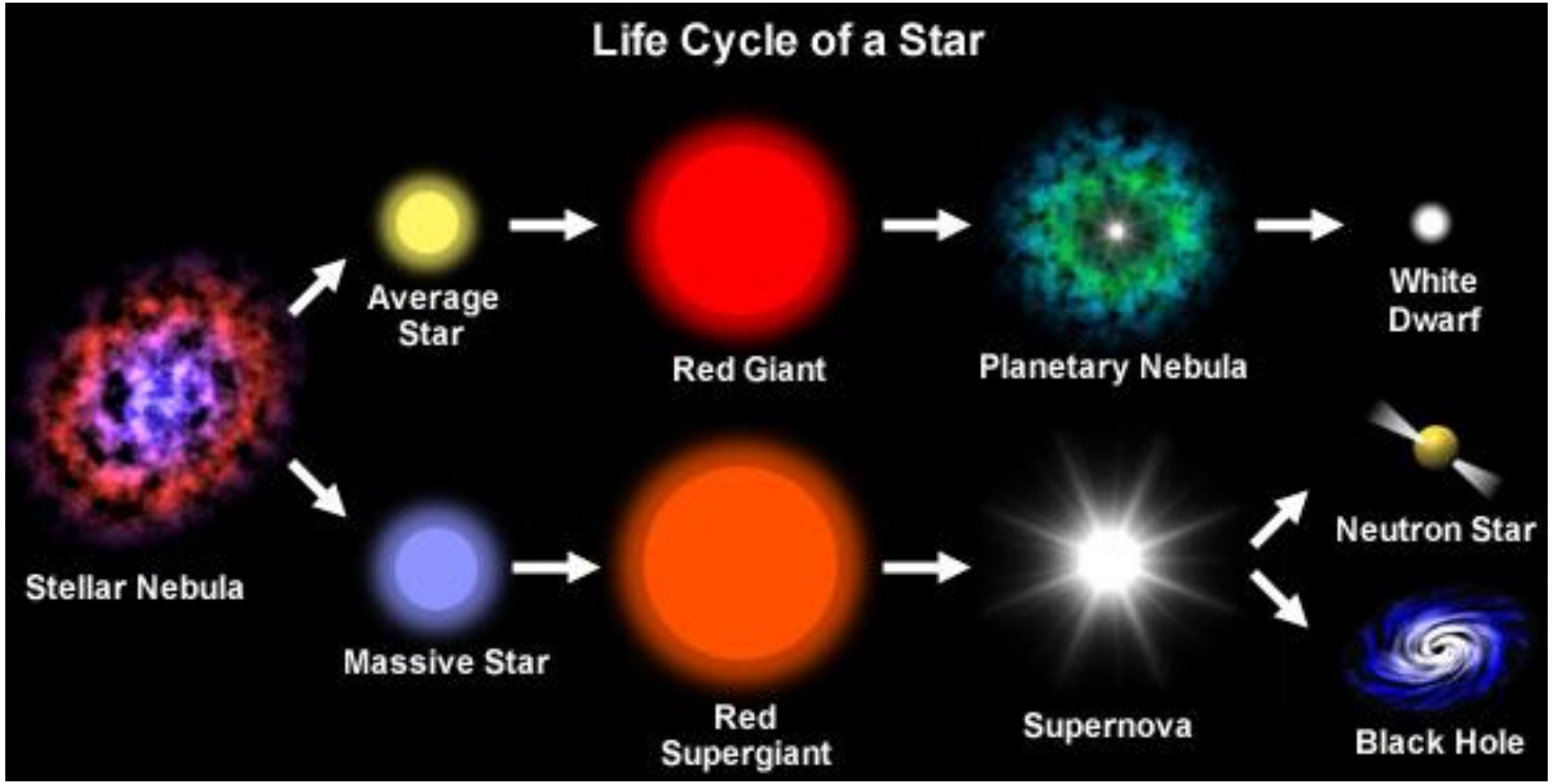

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There should be a few 100,000 black holes in the Milky Way

We have only detected about thirty!

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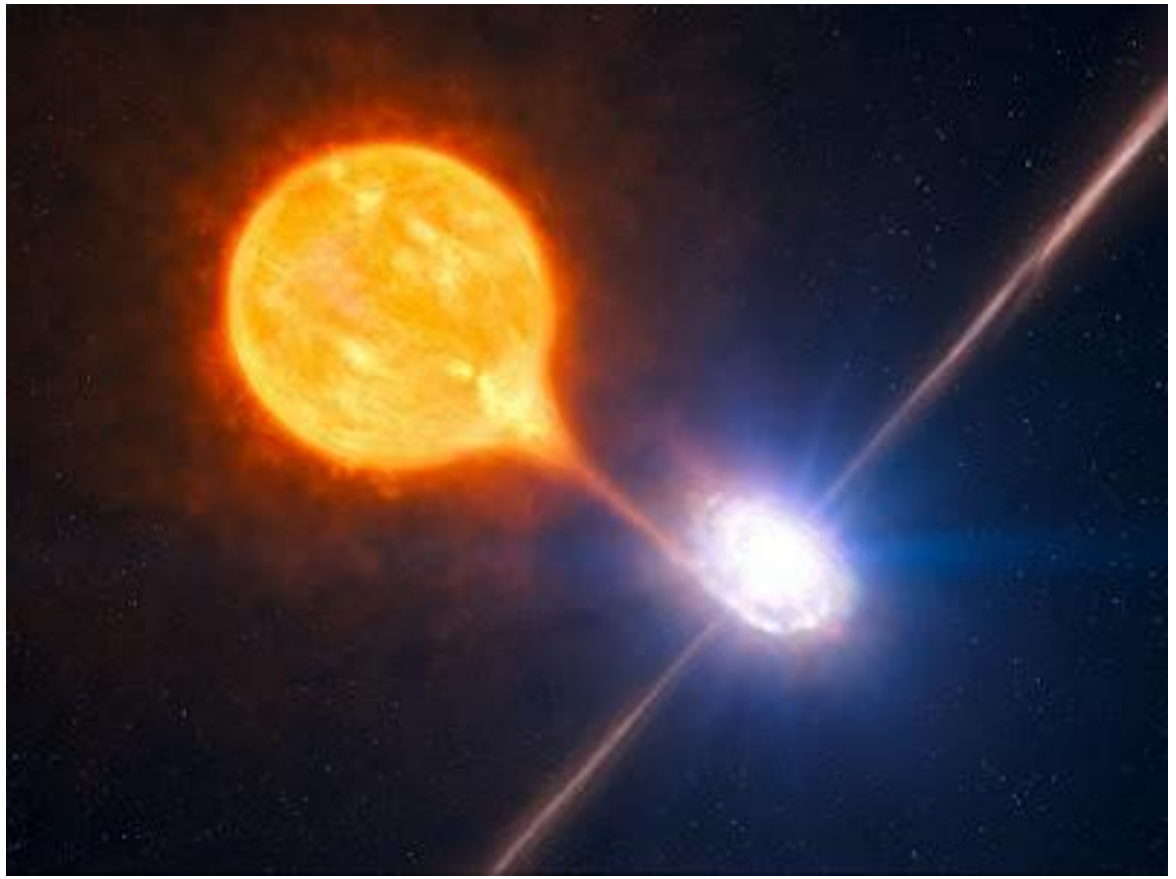

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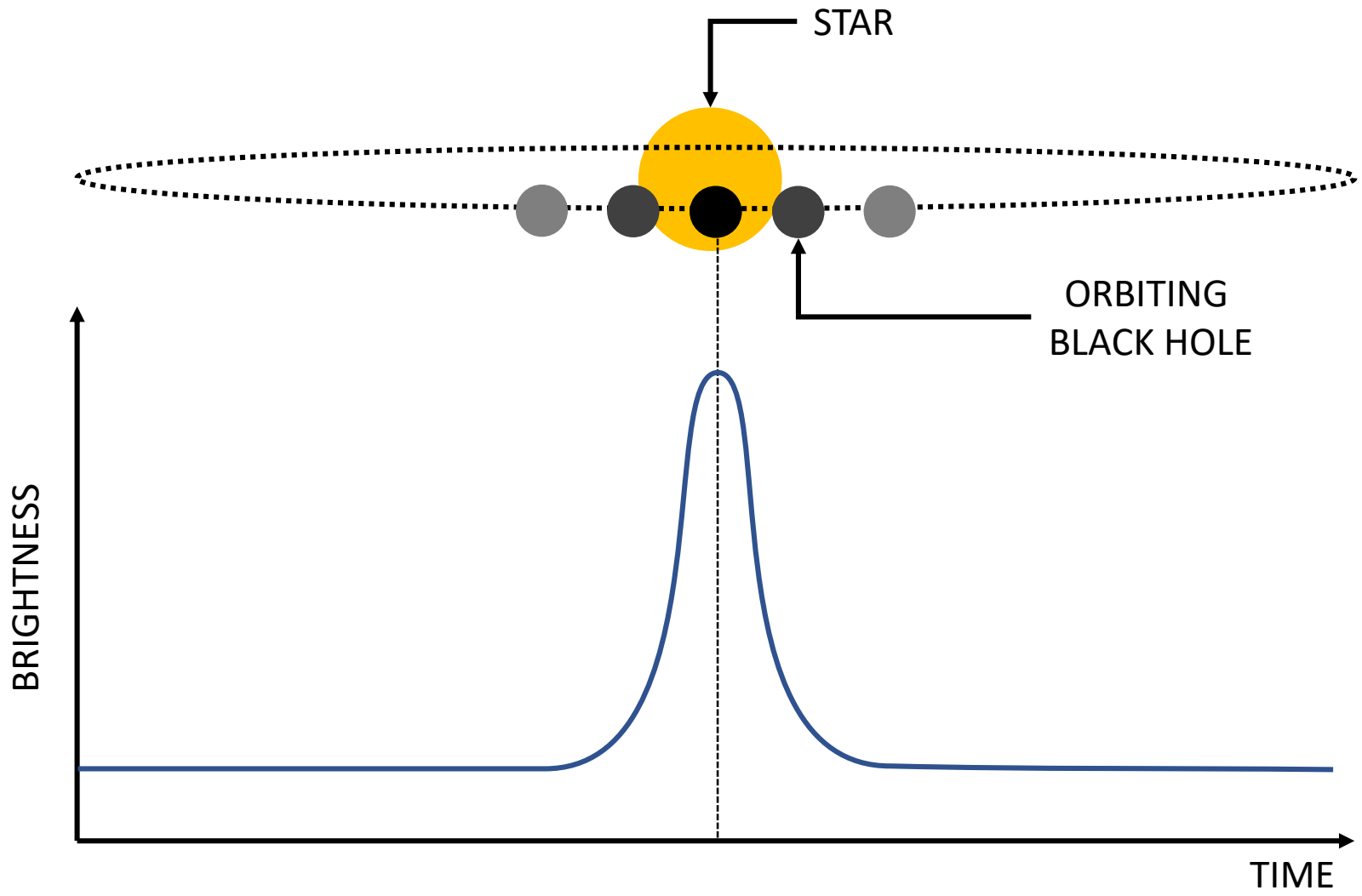

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The Citizen Science Approach

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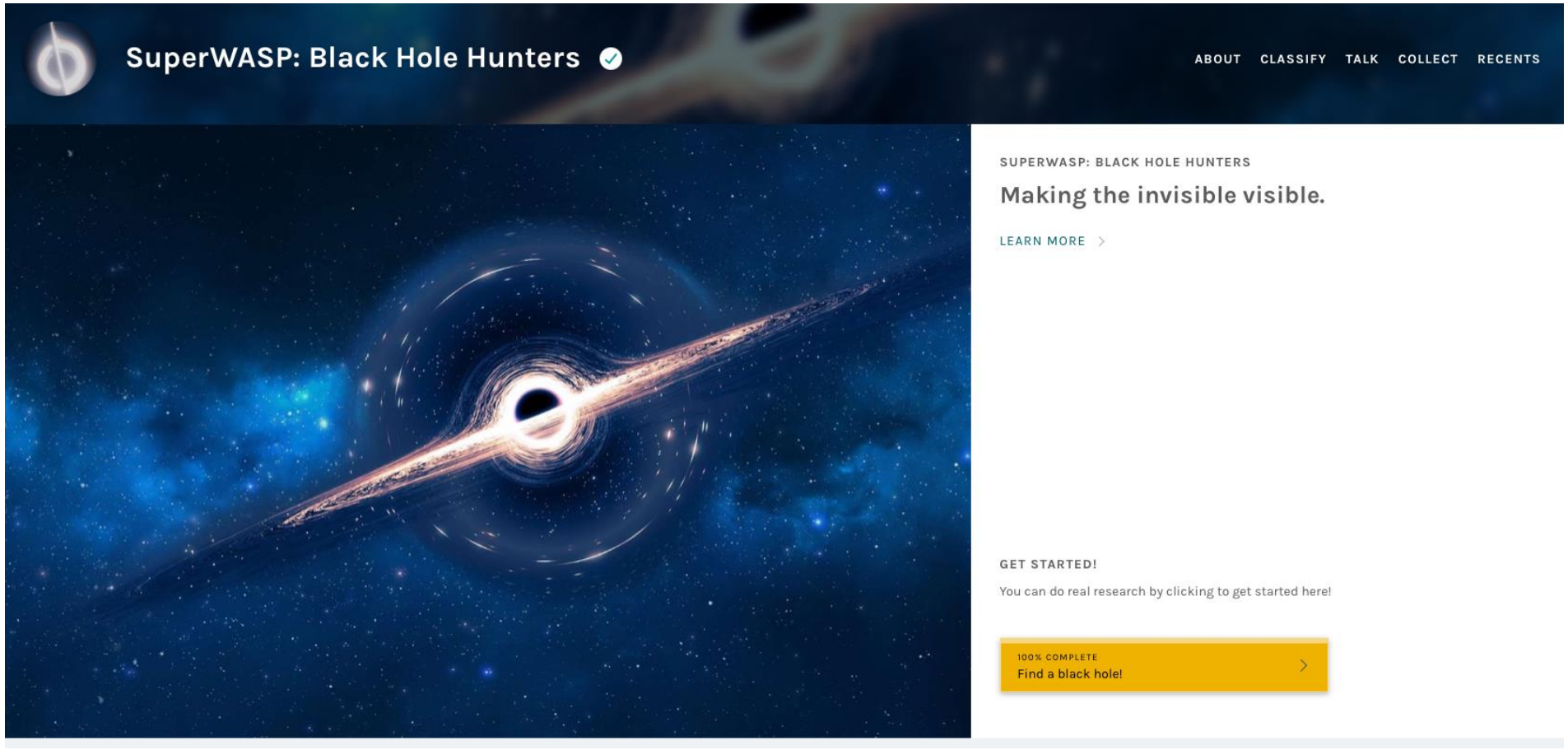
The **W**ide **A**ngle **S**earch for **P**lanets – a ground-based exoplanet search

Two telescopes (North and South)



https://www.zooniverse.org/projects/hughdickinson/superwasp-black-hole-hunters

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What are volunteers looking for?

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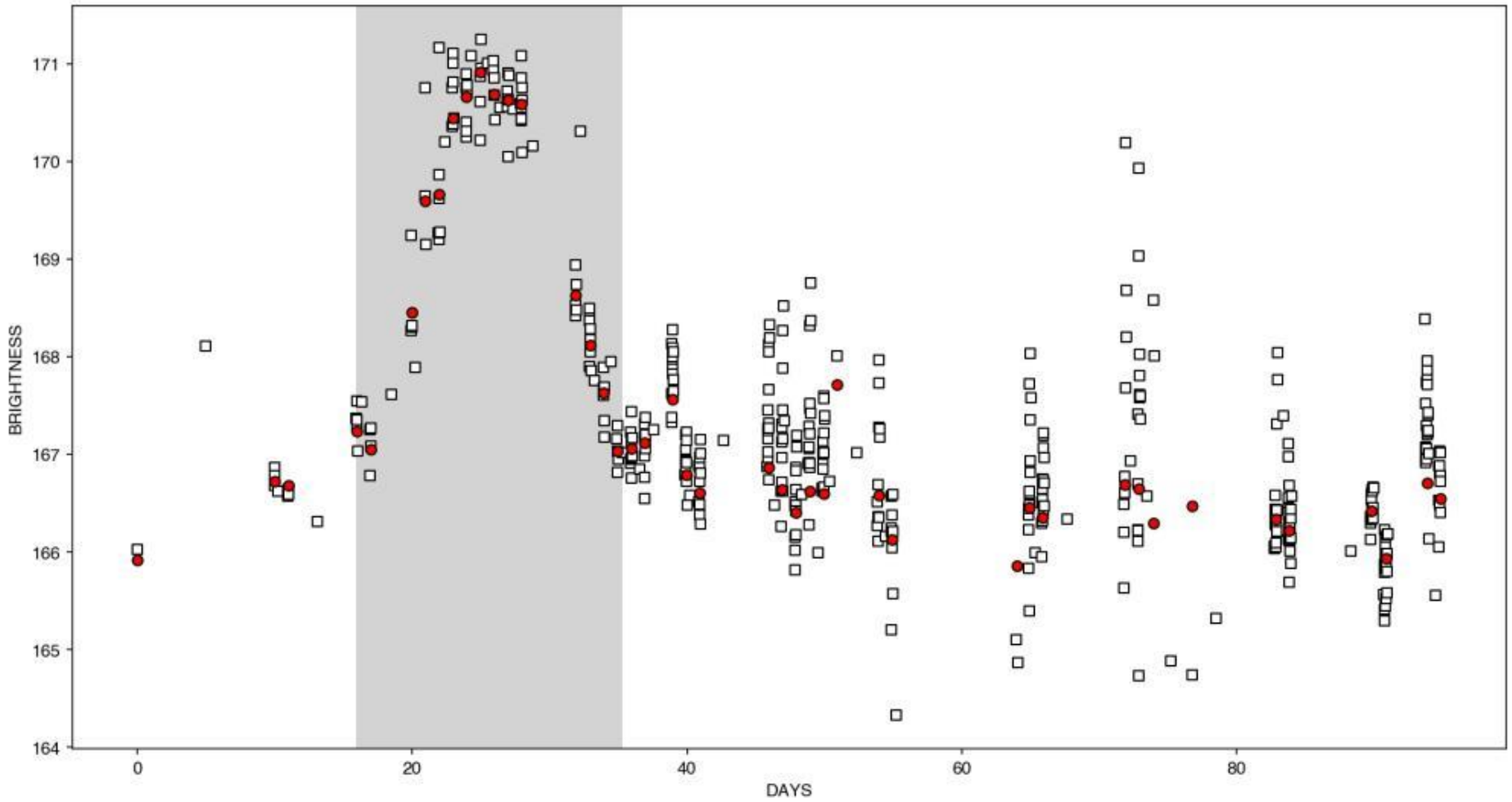

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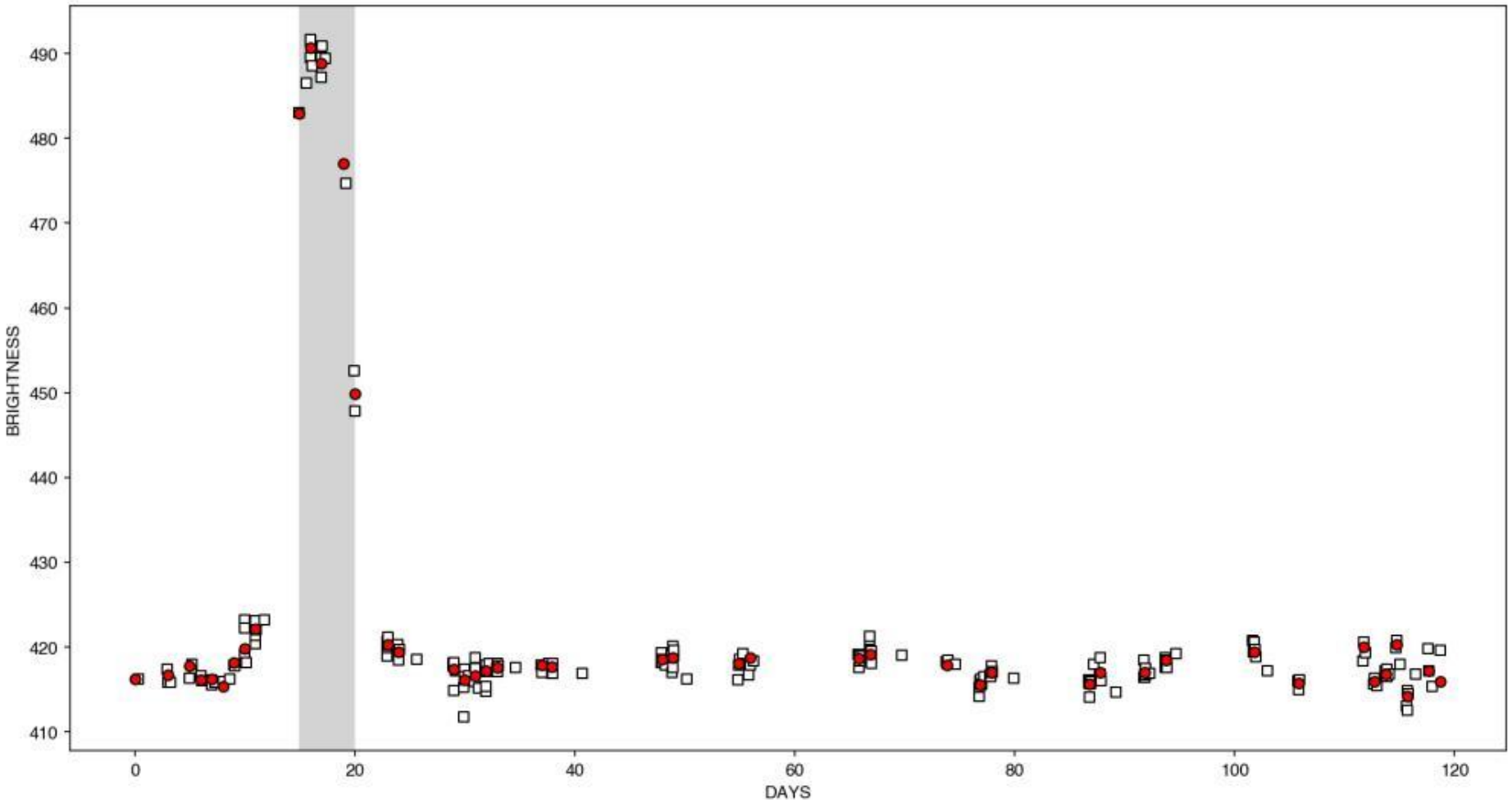

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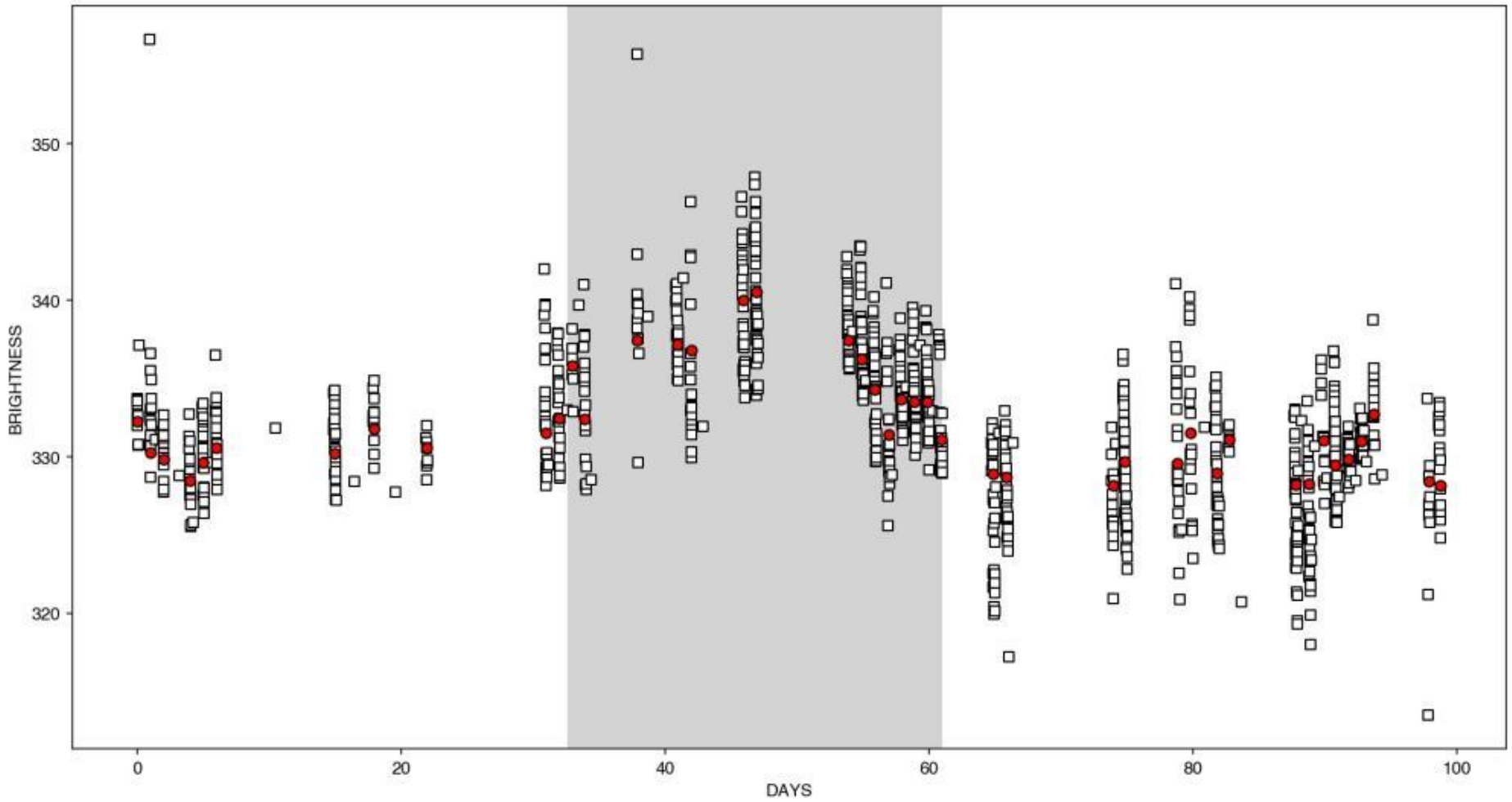

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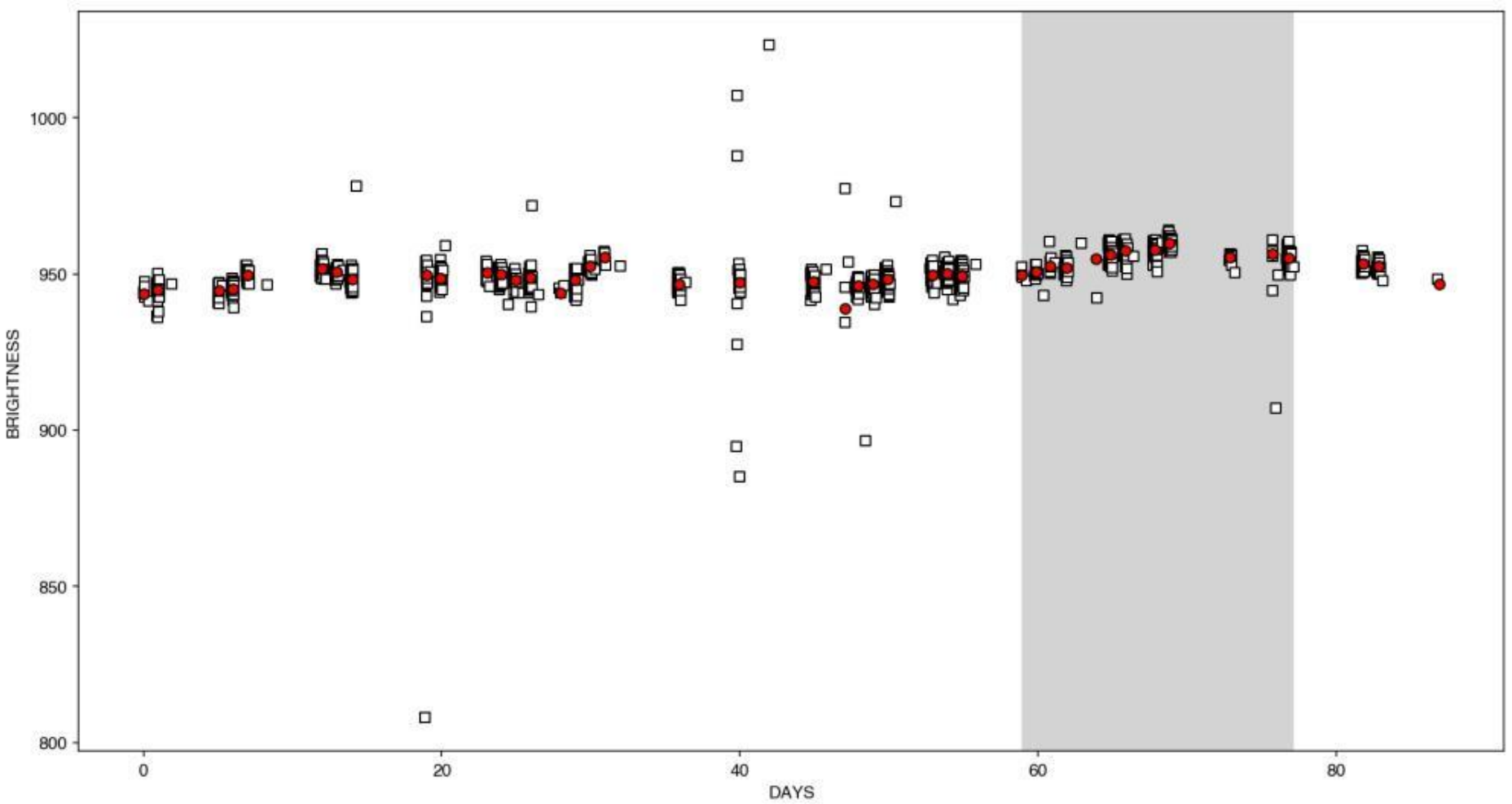

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What are volunteers looking at?

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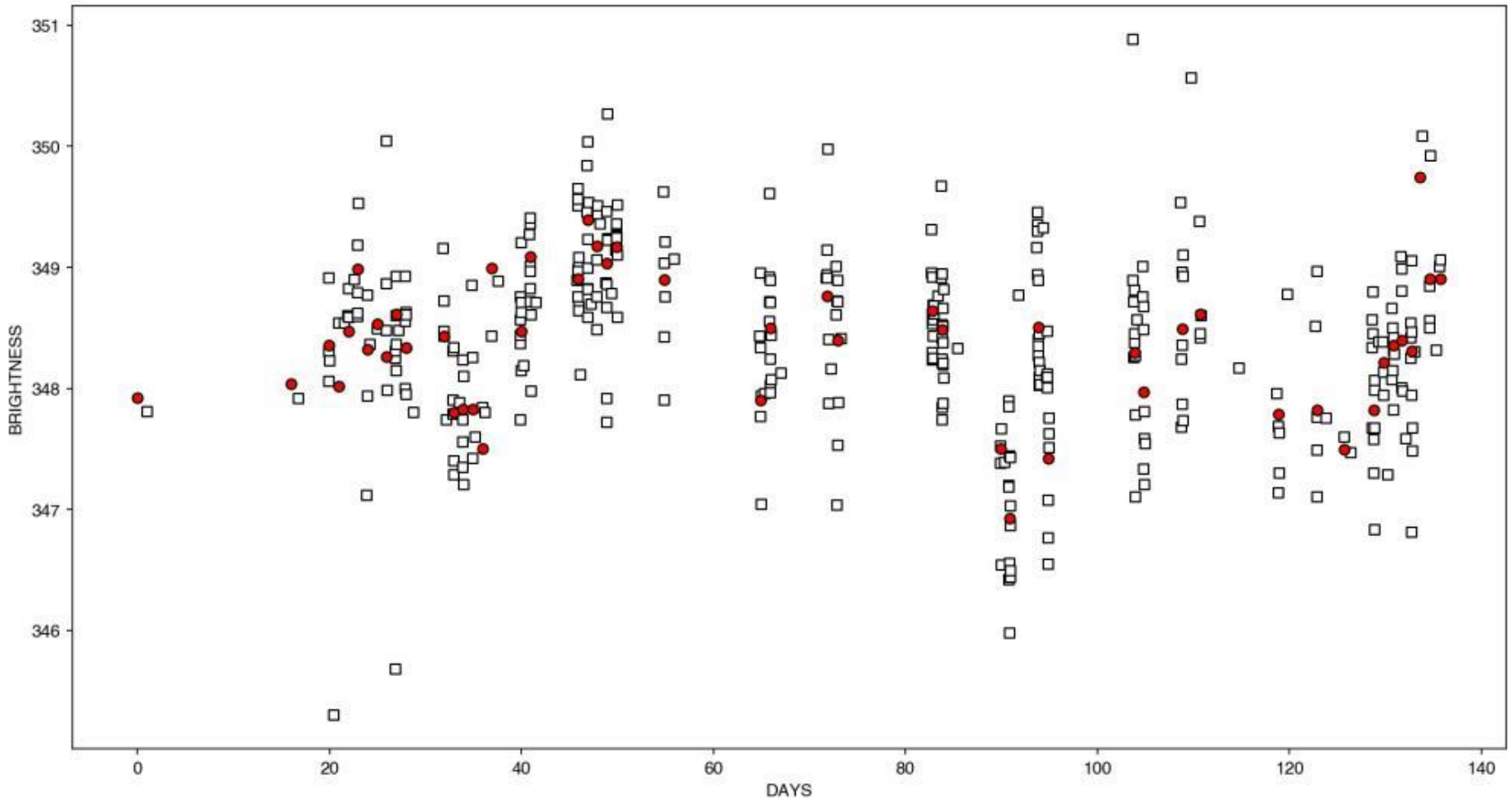

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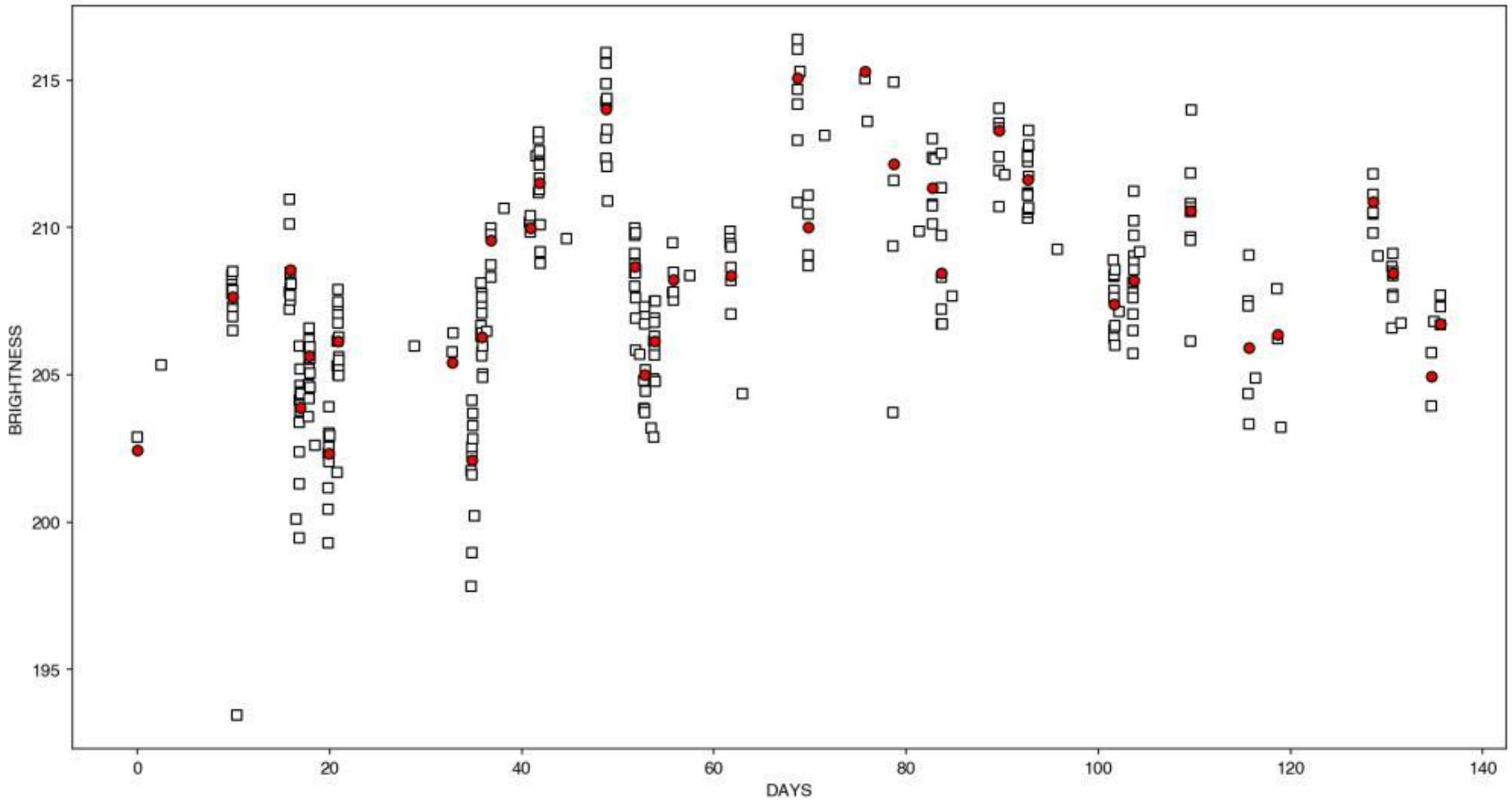

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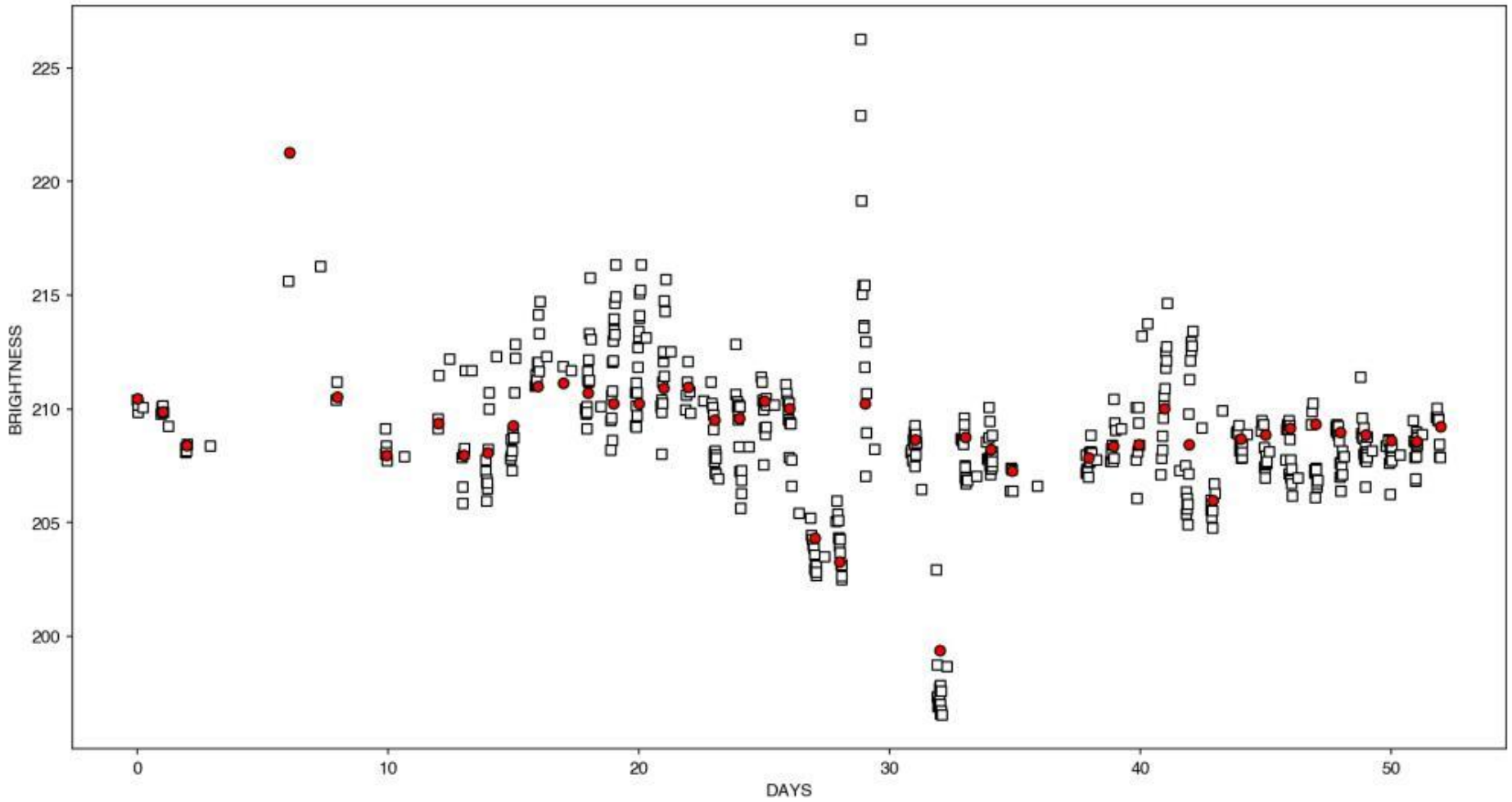

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Big numbers!

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Number of Volunteers engaged:

5,582

Number of light curves inspected:

208,700

Total number of classifications:

2,107,767

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Analysing the results

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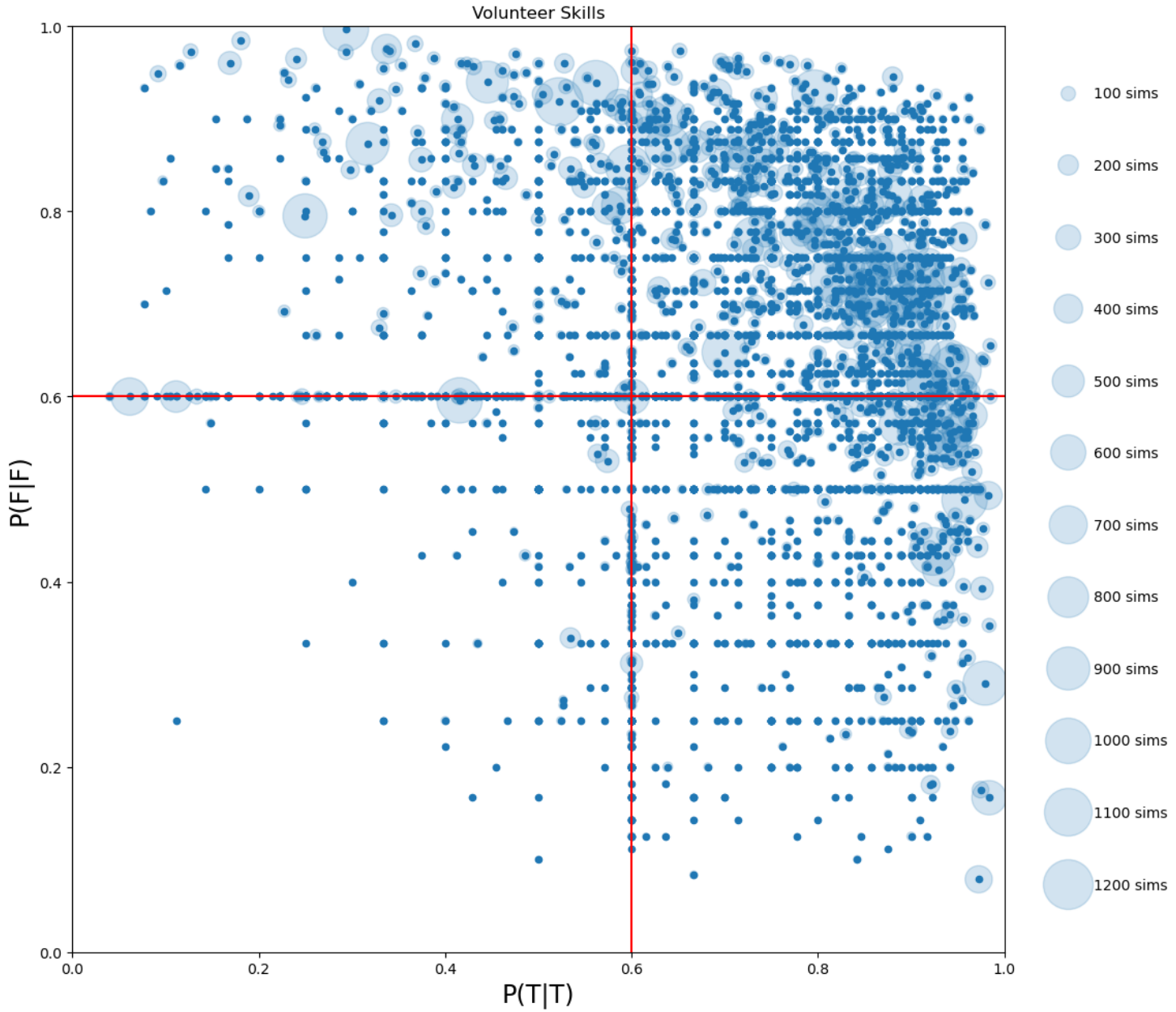

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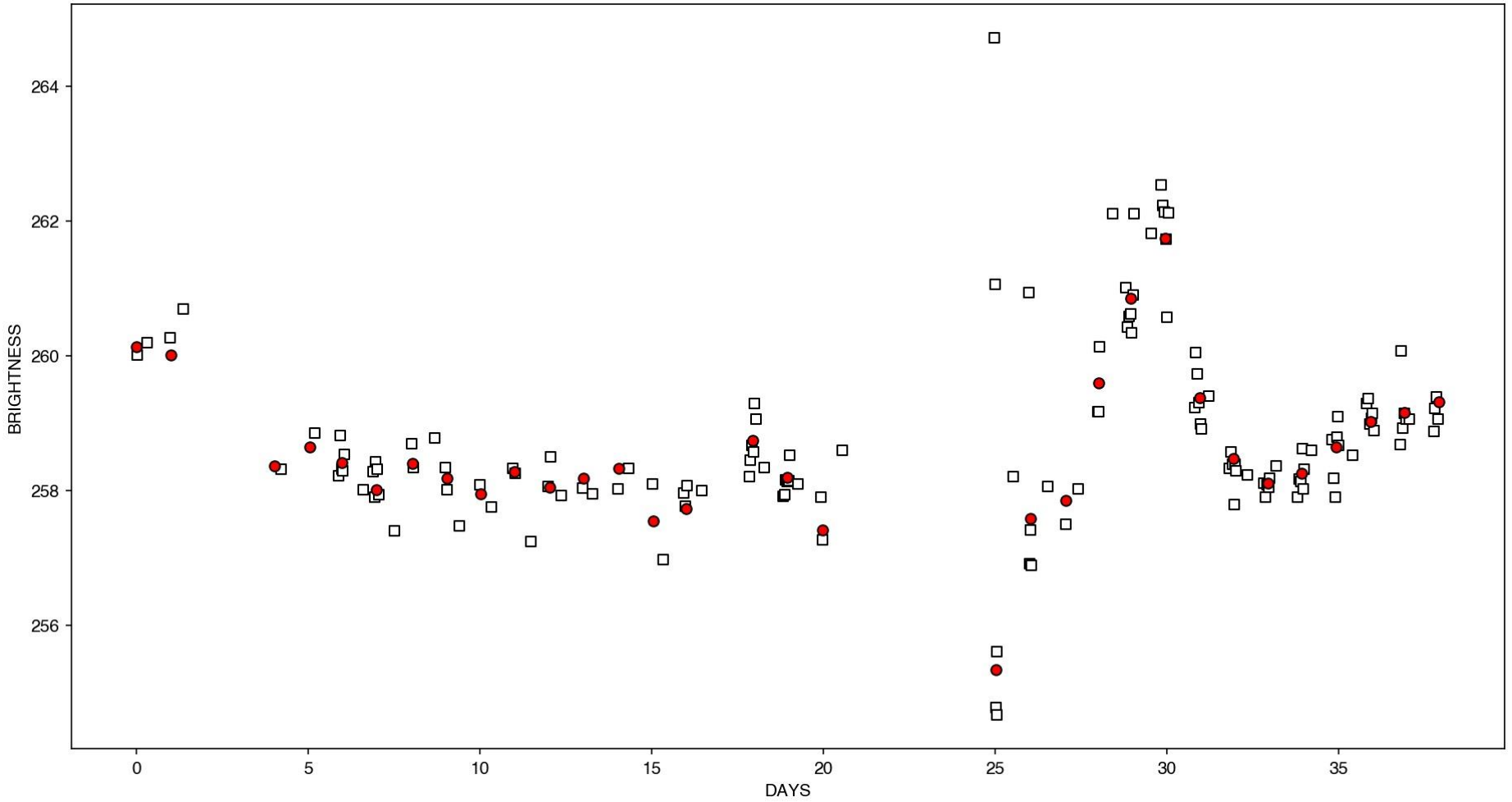

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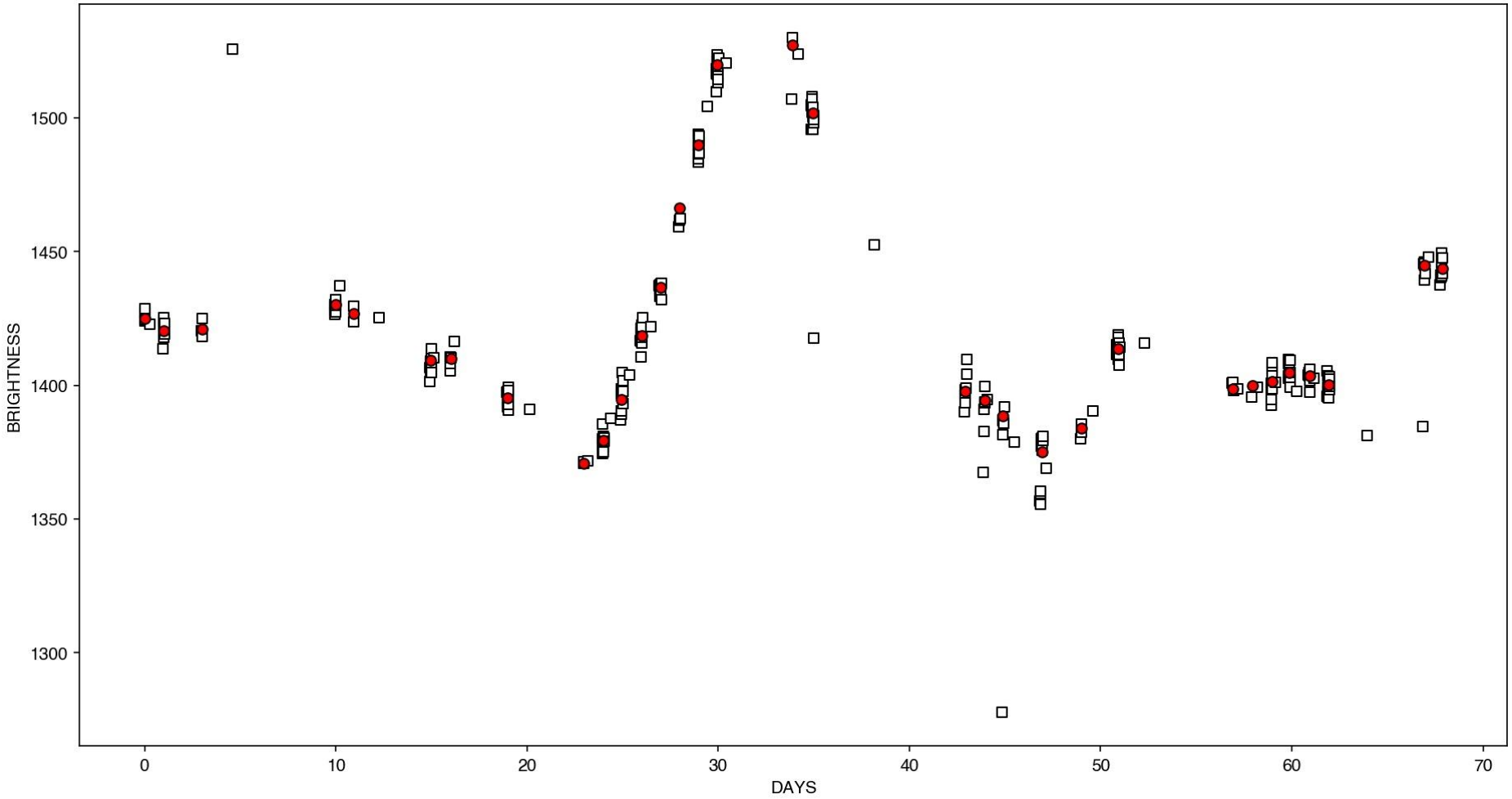

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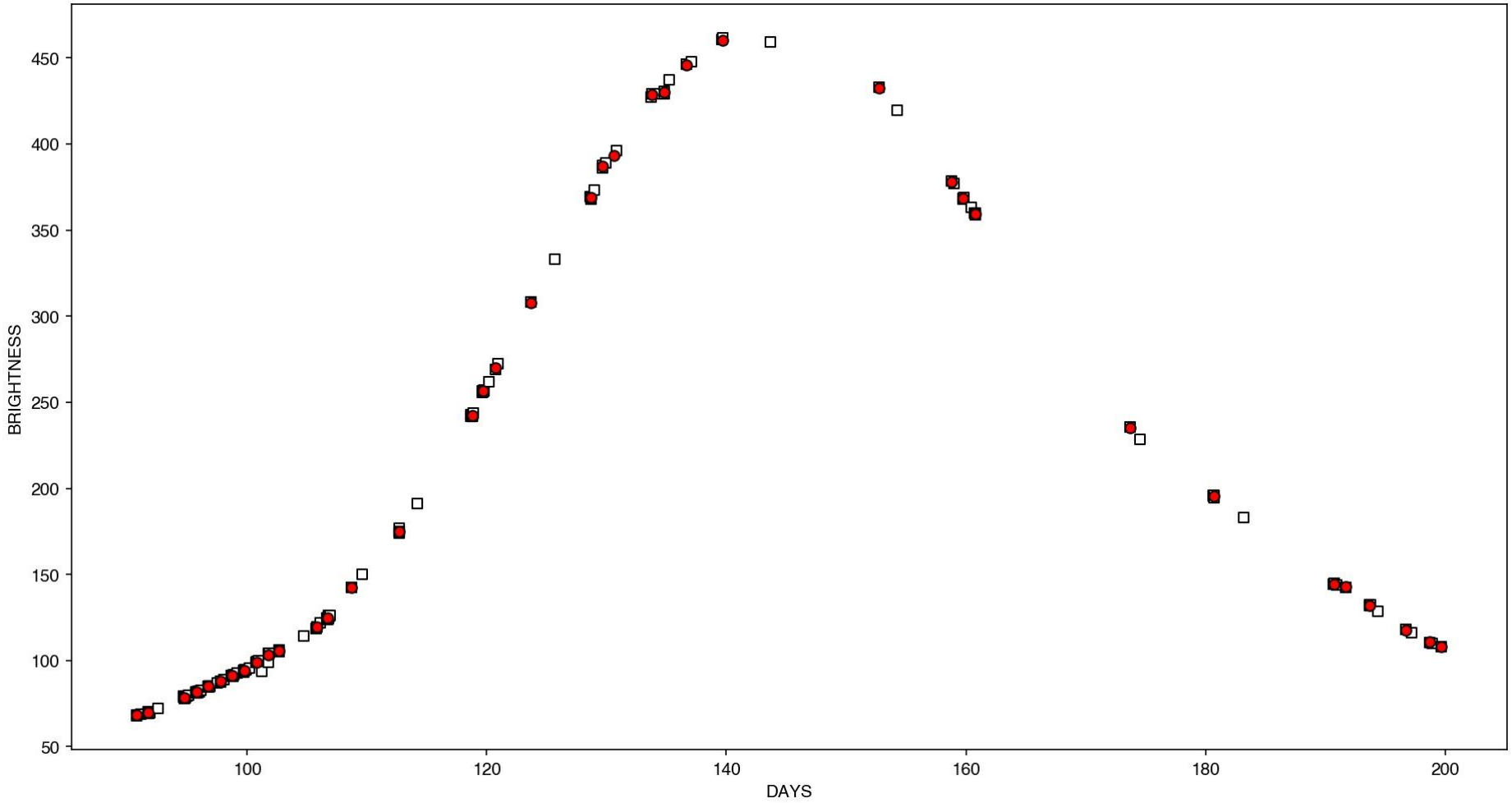

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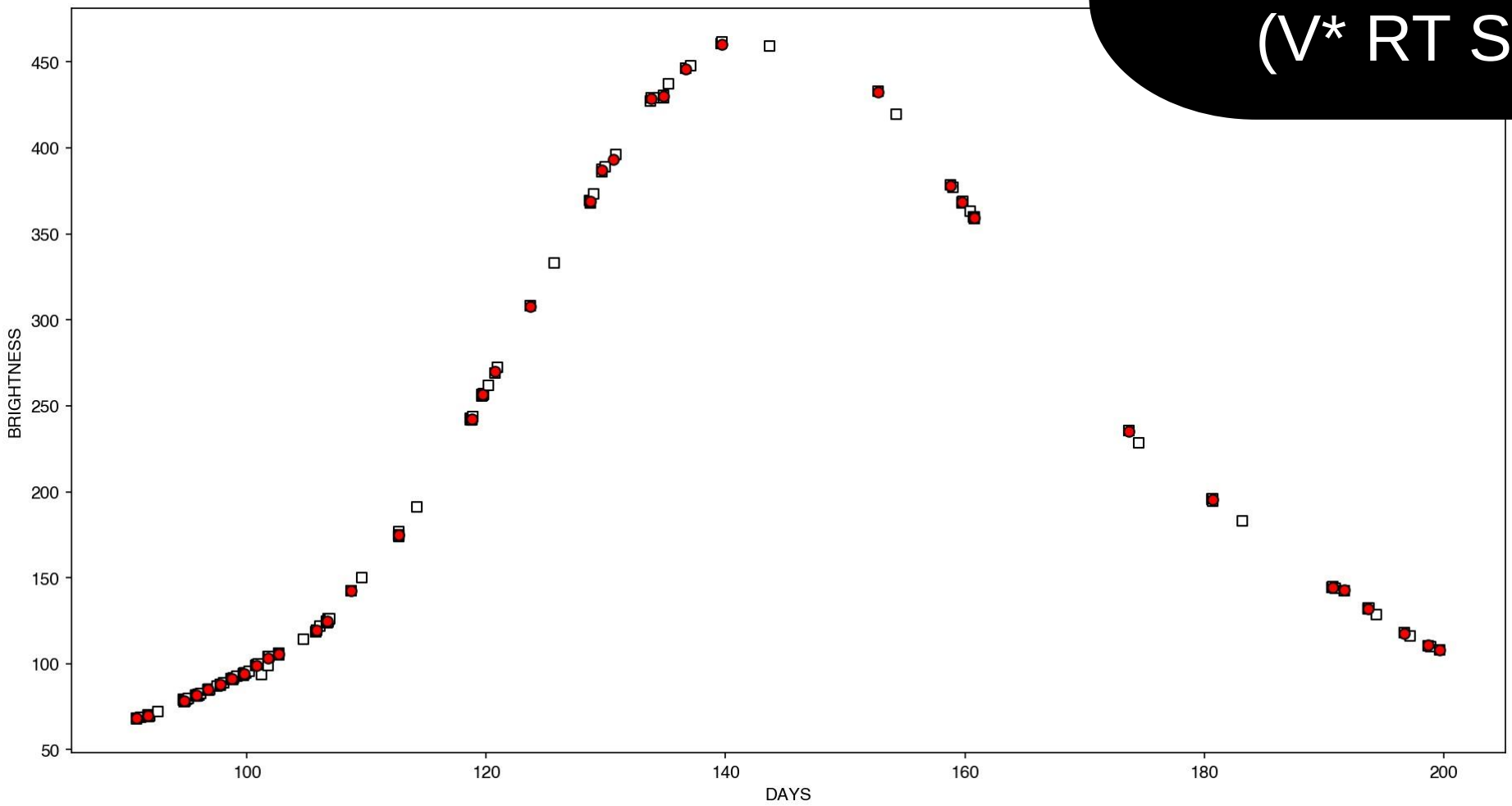
Mira Variable Star (V* RT Sgr)



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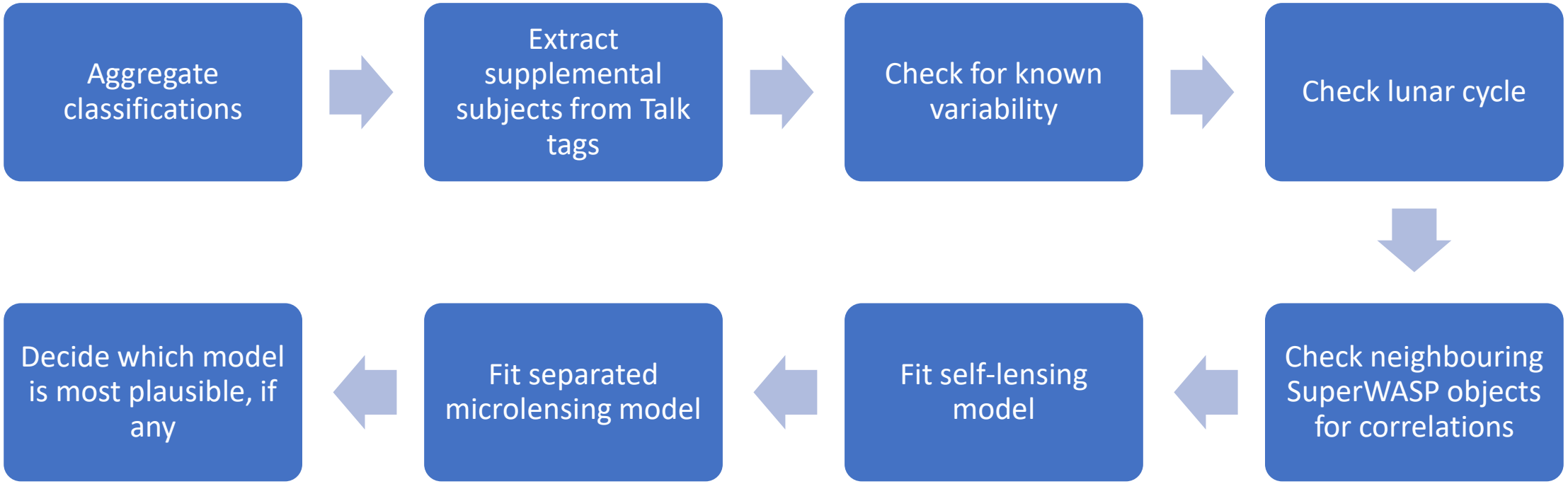
Aggregate classifications
Extract supplemental subjects from Talk tags
Check for known variability
Check lunar cycle
Check neighbouring SuperWASP objects for correlations
Fit self-lensing model
Fit separated microlensing model
Decide which model is most plausible, if any

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Analysis is ongoing - watch this space!

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Bonus: Meeting the volunteers!

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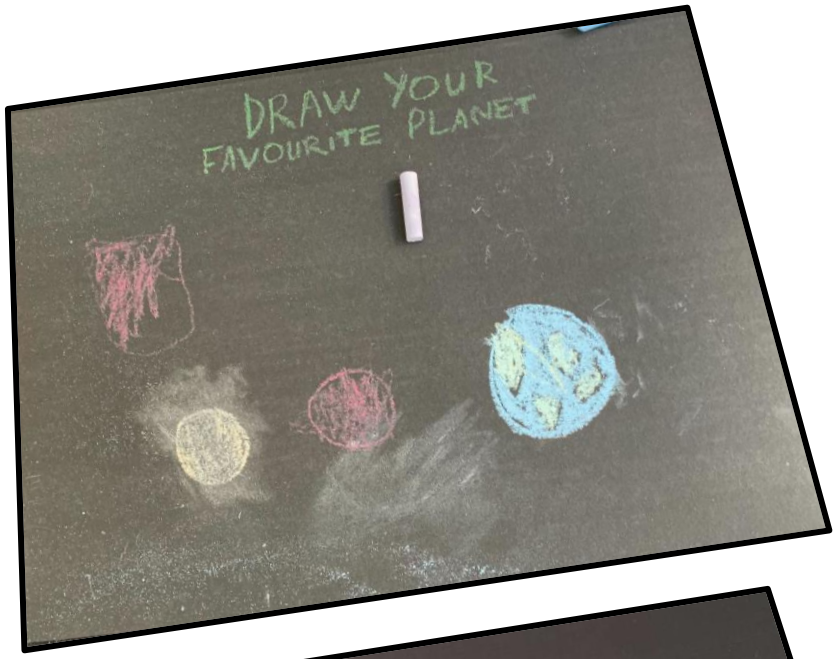

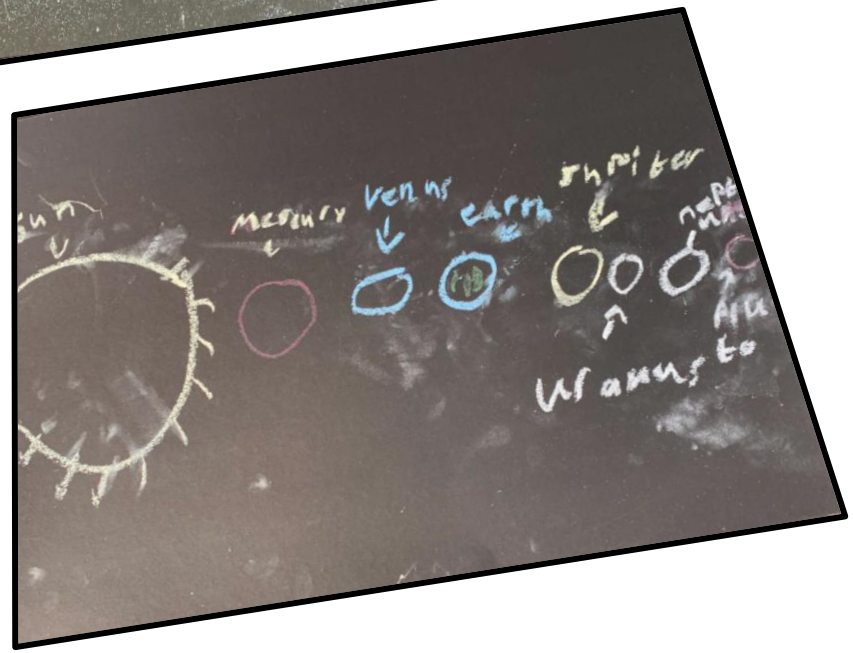

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Thanks

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Brussels, Belgium

ESCAPE Citizen Science
Galaxy Zoo: Clump Scout

Hugh Dickinson – The Open University

Team: Nico Adams, Vihang Mehta, Lucy Fortson, Claudia Scarlata, Stephen Serjeant *+ Galaxy Zoo Team*

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Searching for Giant Star-forming Clumps

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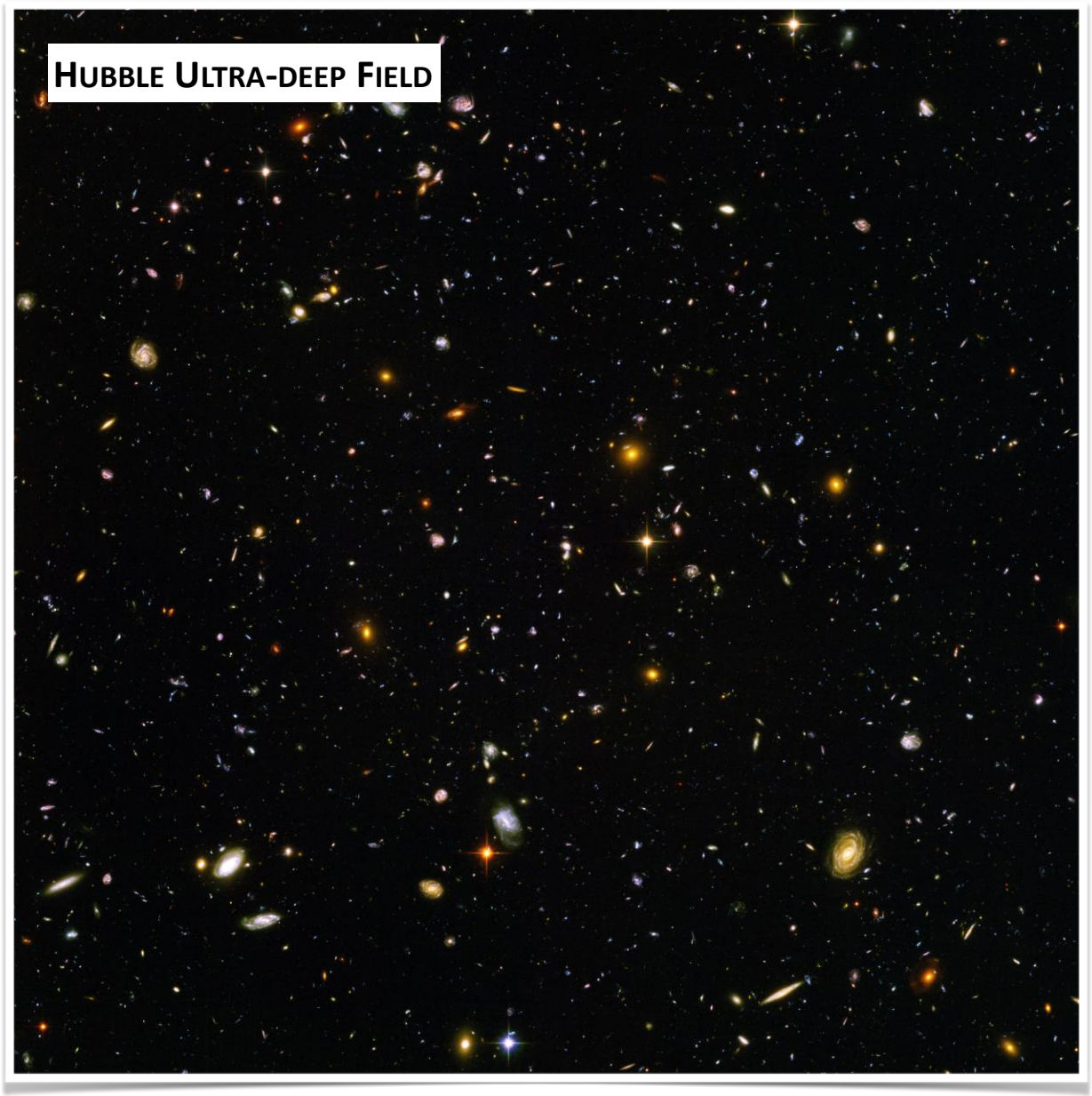

NASA, ESA, S. Beckwith (STScI) and the HUDF Team

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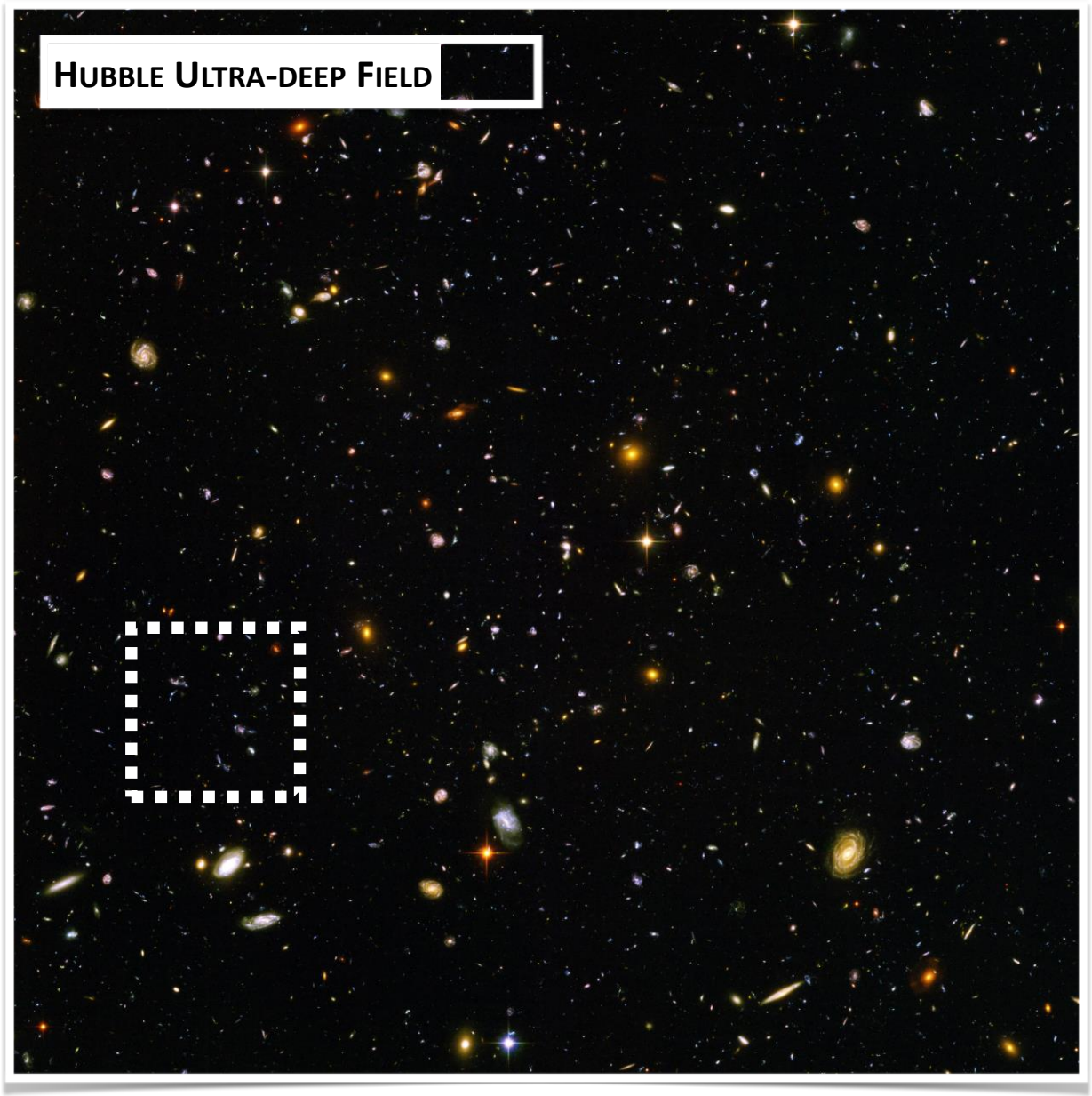
Hubble Image: NASA, ESA, K. Kuntz (JHU), F. Bresolin (University of Hawaii), J. Trauger (Jet Propulsion Lab),
J. Mould (NOAO), Y. H. Chu (University of Illinois, Urbana) and STScI;
CFHT Image: Canada-France-Hawaii Telescope/J.-C. Cuillandre/Coelum; NOAO Image: G. Jacoby, B. Bohannan, M. Hanna/NOAO/AURA/NSF

ESCAPE - The European Science Cluster of Astronomy & Particle Physics ESFRI Research Infrastructures has received funding from the European Union's Horizon 2020 research and innovation programme under Grant Agreement no. 824064.



NASA, ESA, S. Beckwith (STScI) and the HUDF Team

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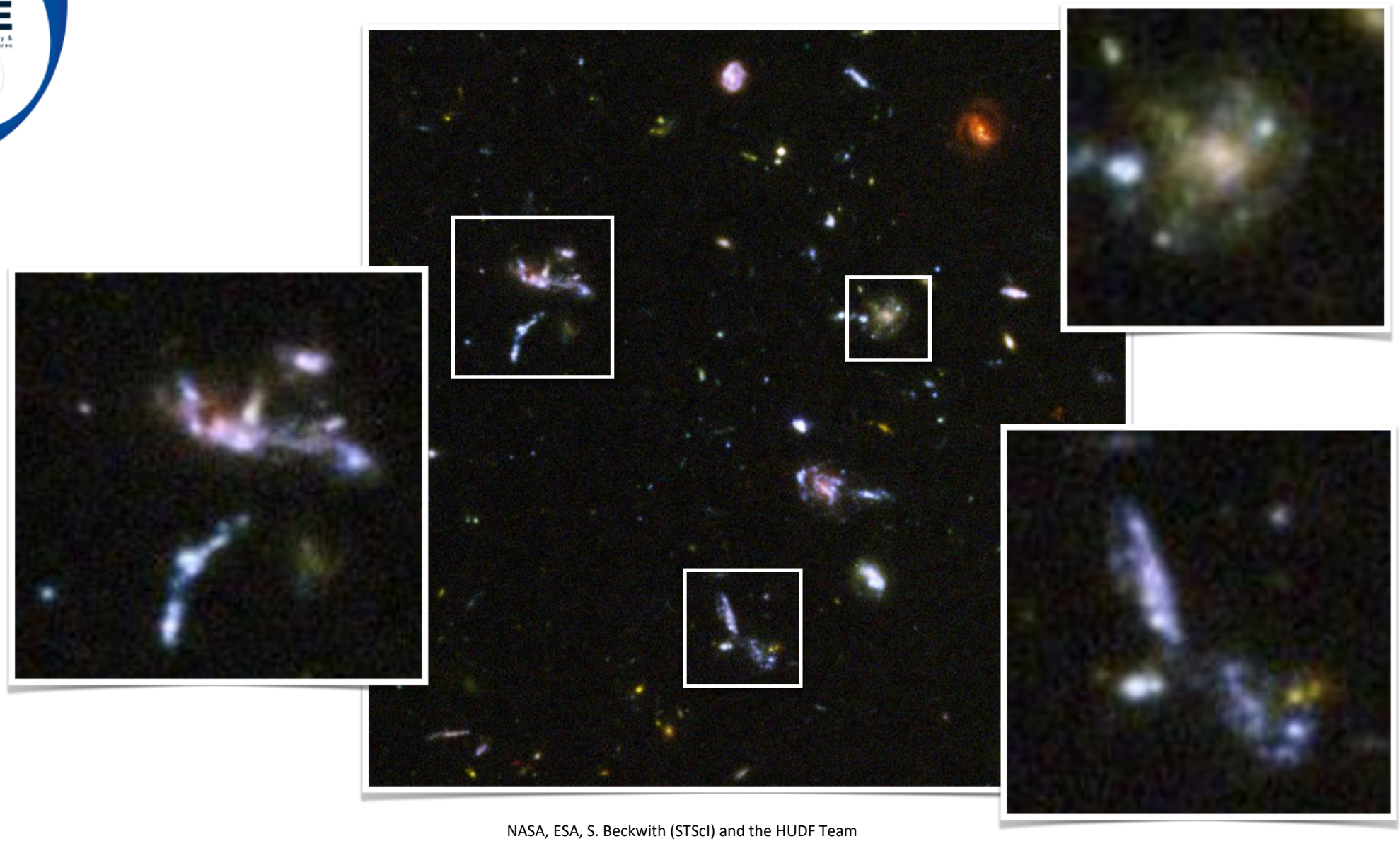

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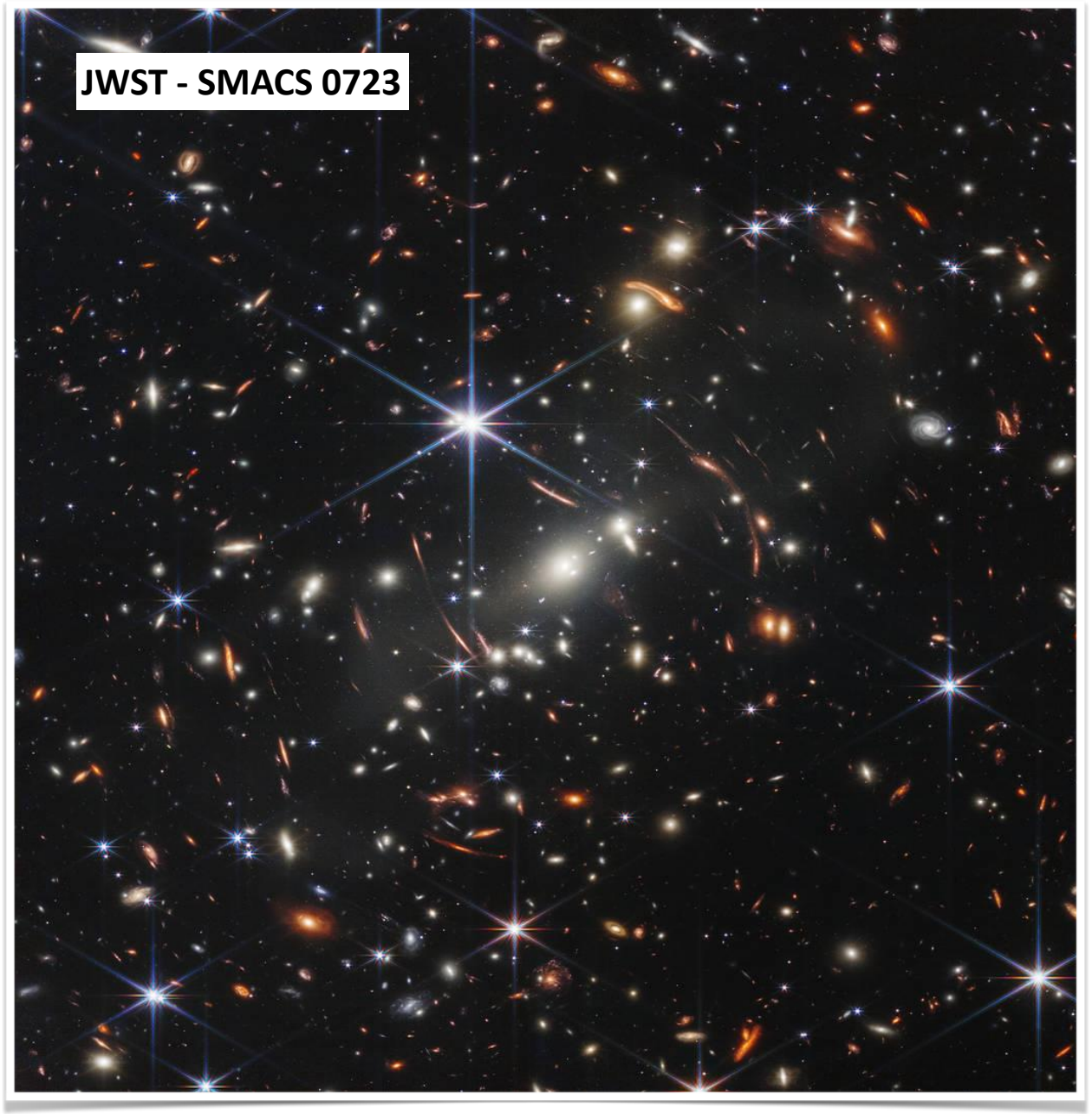

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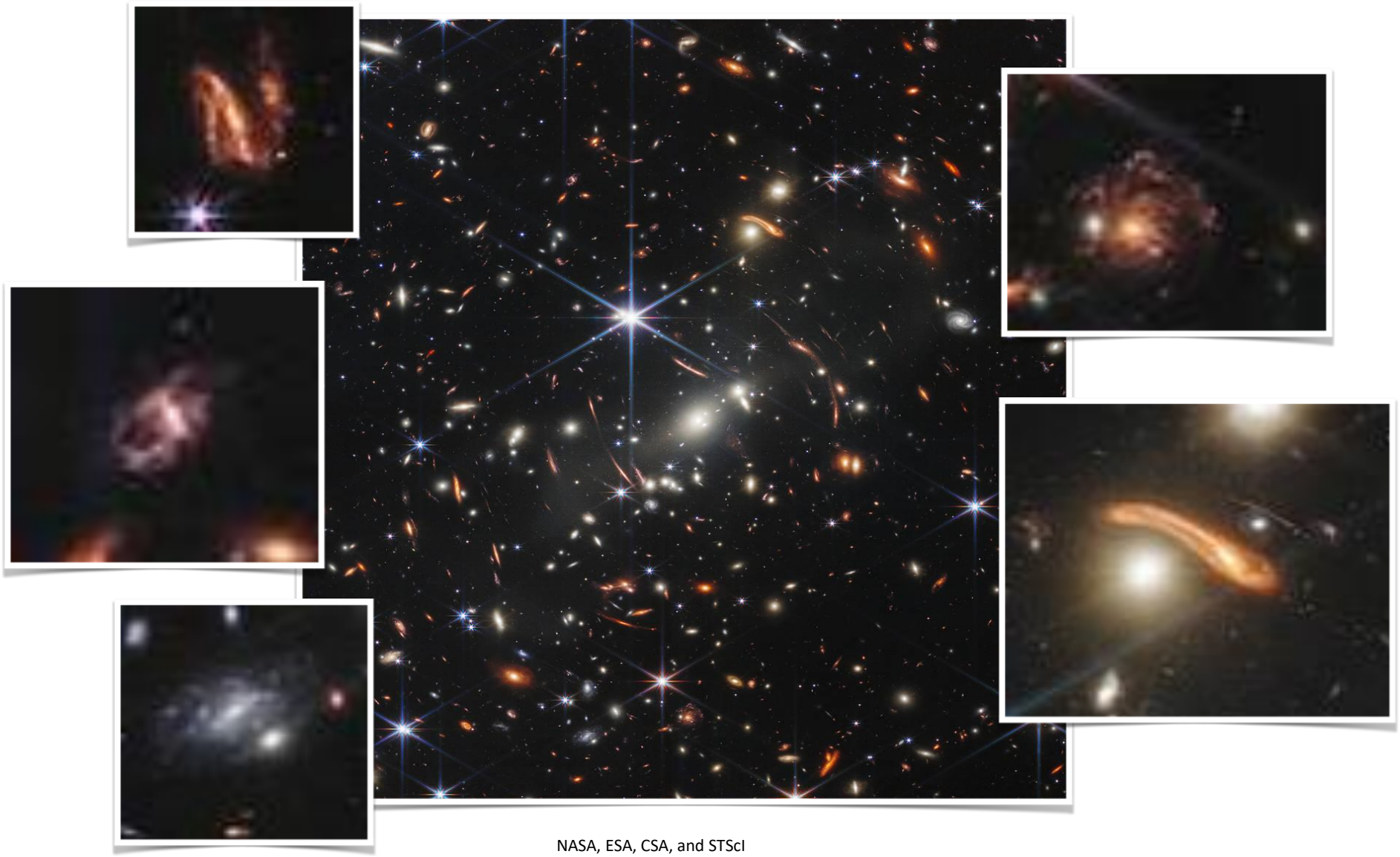

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Why are clumpy galaxies important?

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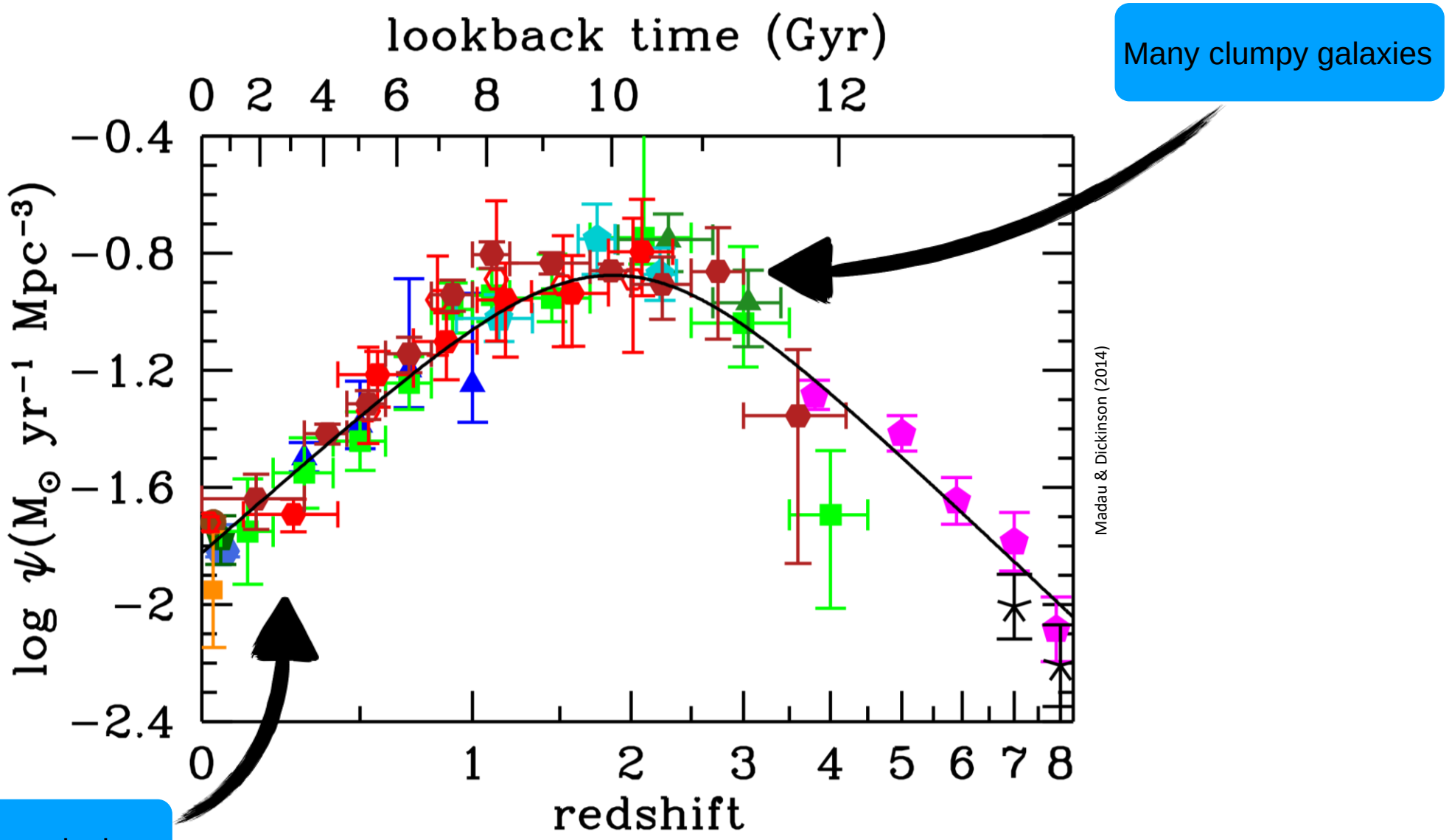

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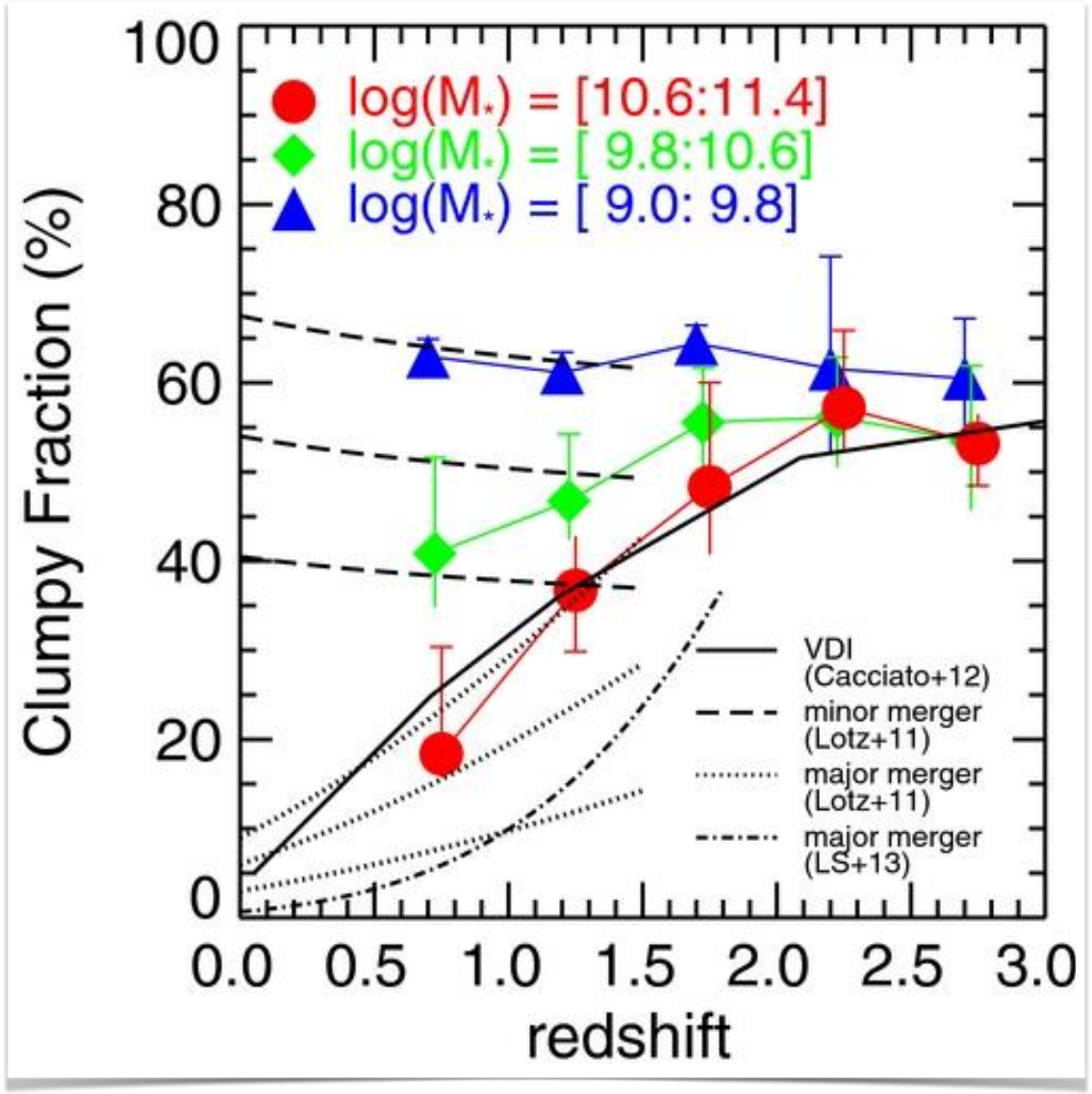

Guo et al. (2015)

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Finding nearby clumpy galaxies

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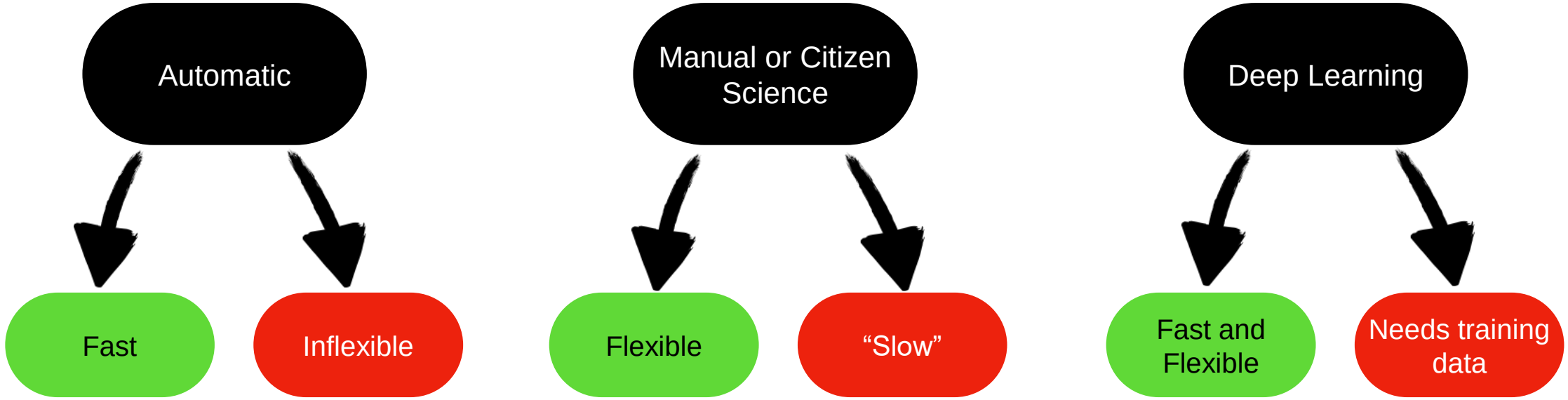
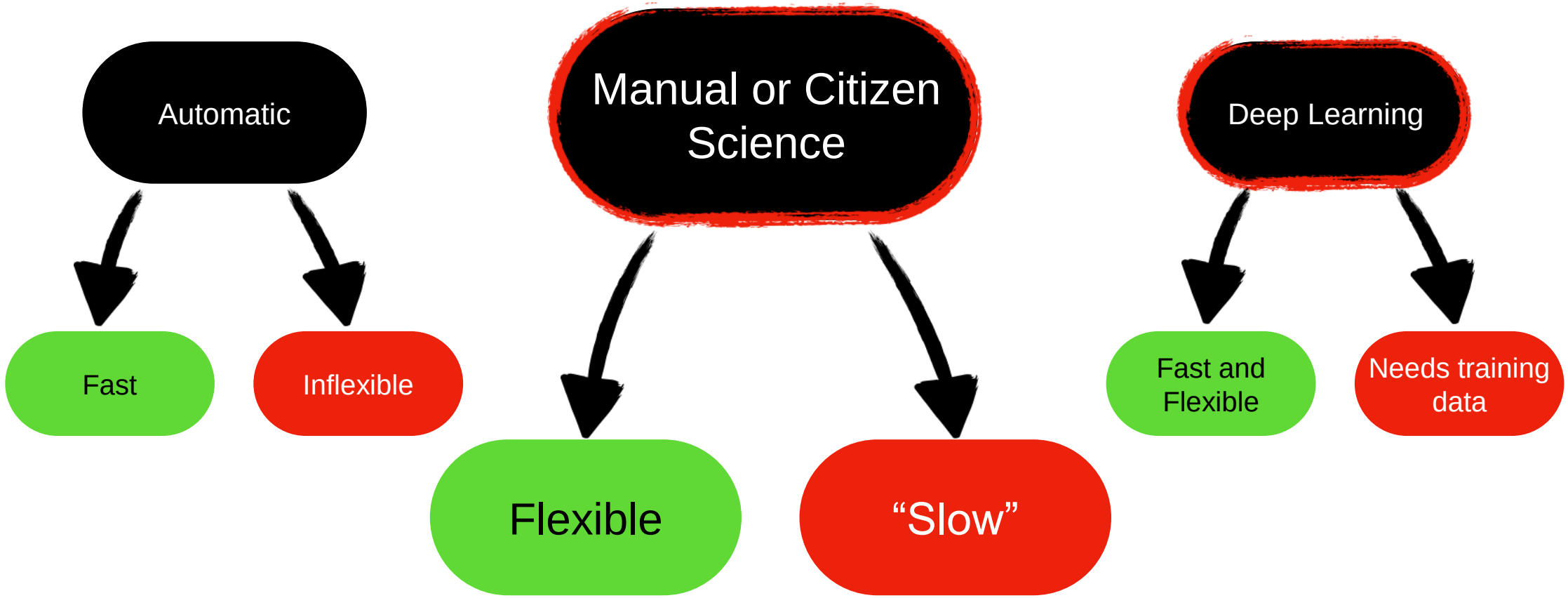

Automatic
Fast
Inflexible
Manual or Citizen Science
Flexible
“Slow”
Deep Learning
Fast and Flexible
Needs training data


Automatic
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The Citizen Science Approach

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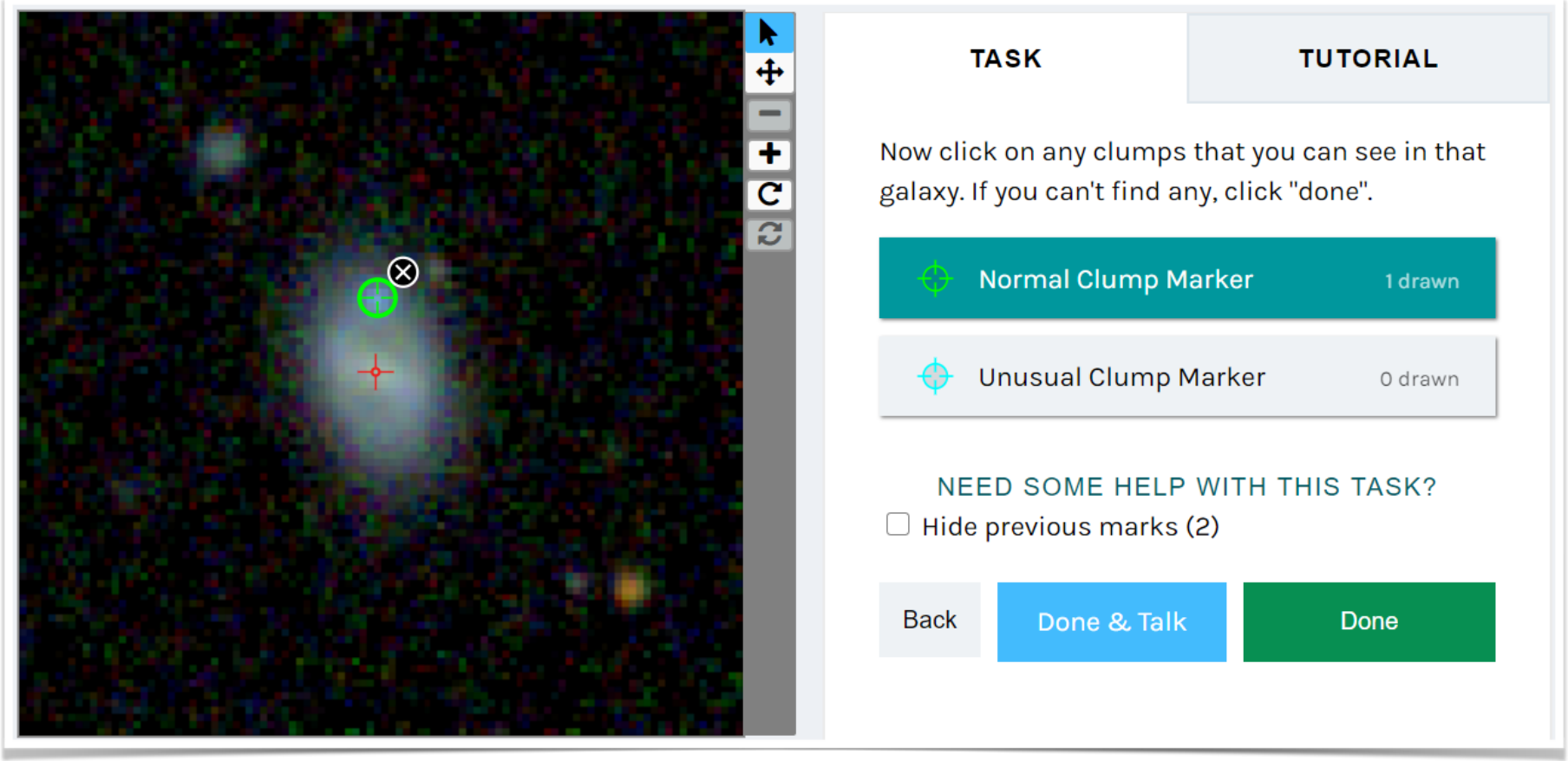

https://www.zooniverse.org/projects/hughdickinson/galaxy-zoo-clump-scout/classify

Number of Volunteers engaged:

~15,000

Number of Galaxies inspected:

~80,000

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The First Rule of Citizen Science

“Nobody Reads the Tutorial”

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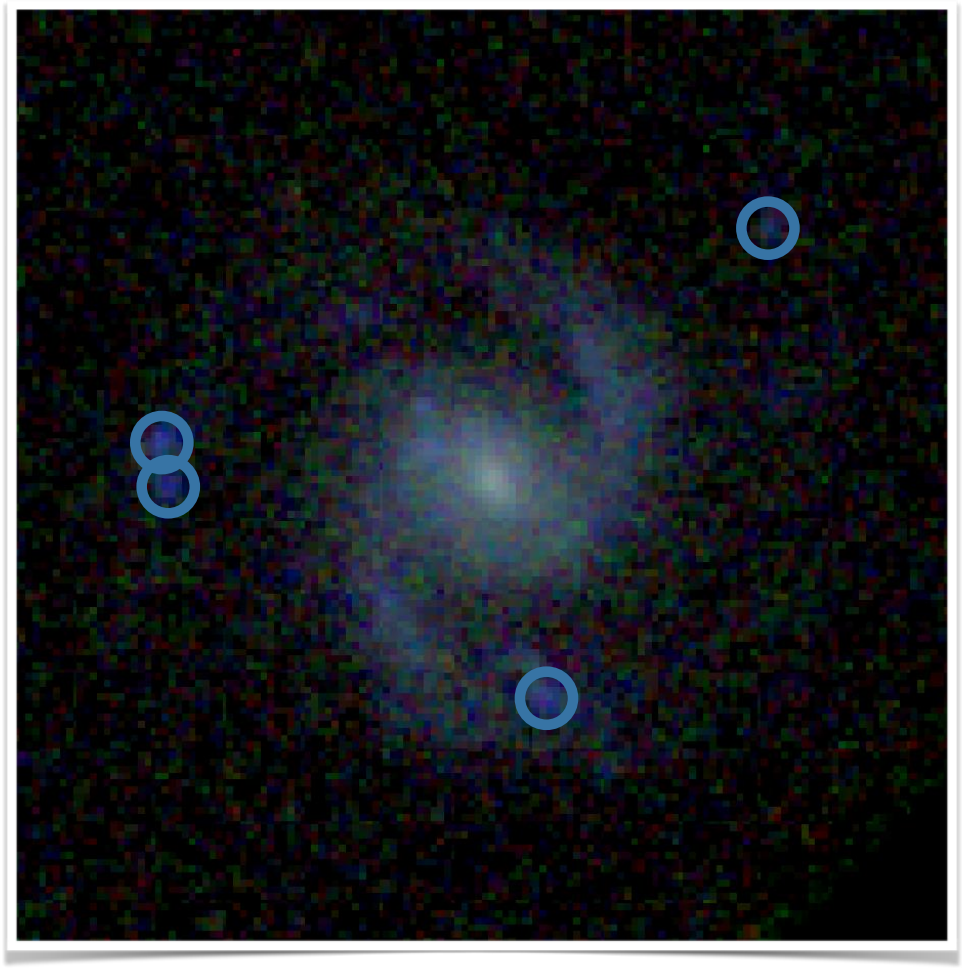

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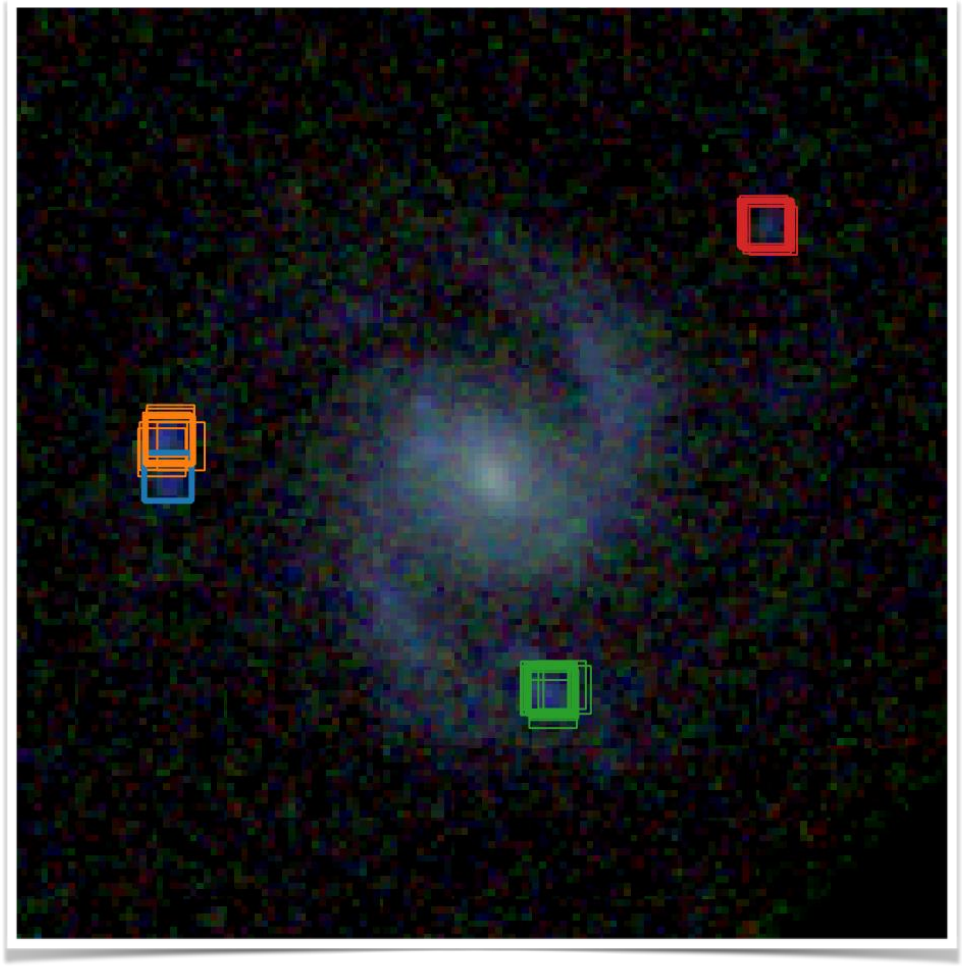

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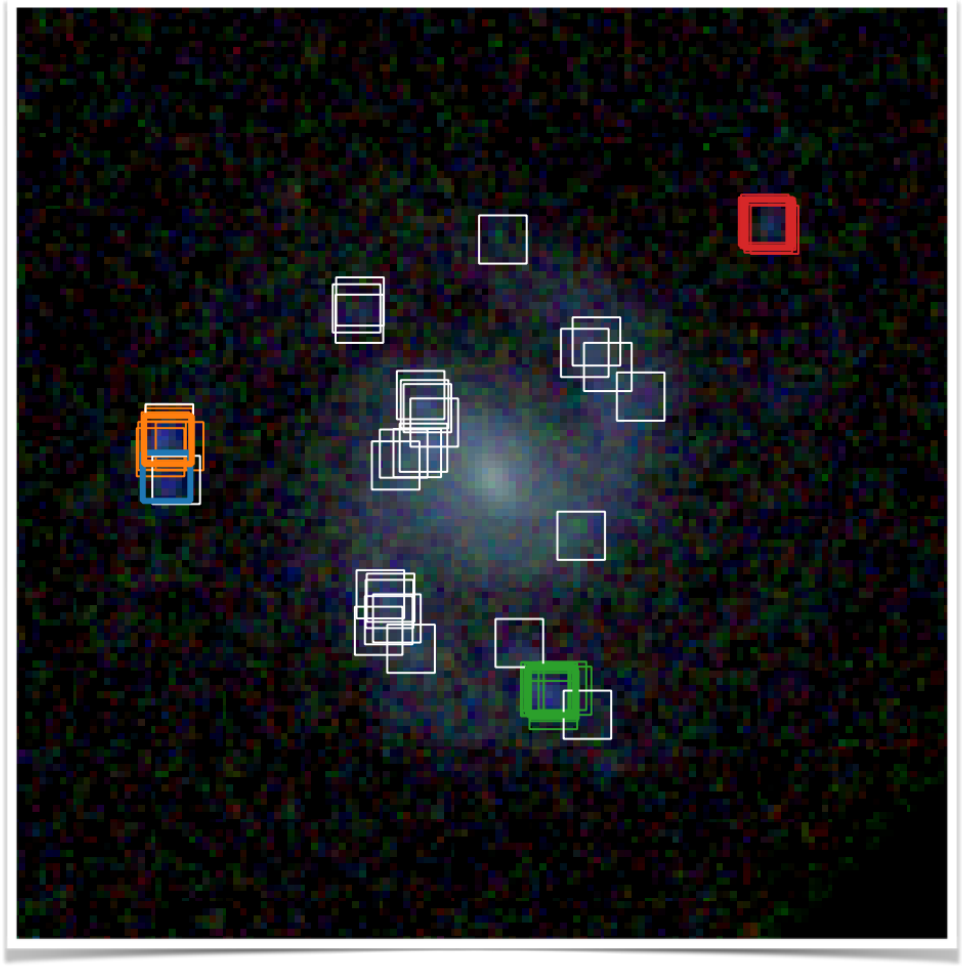

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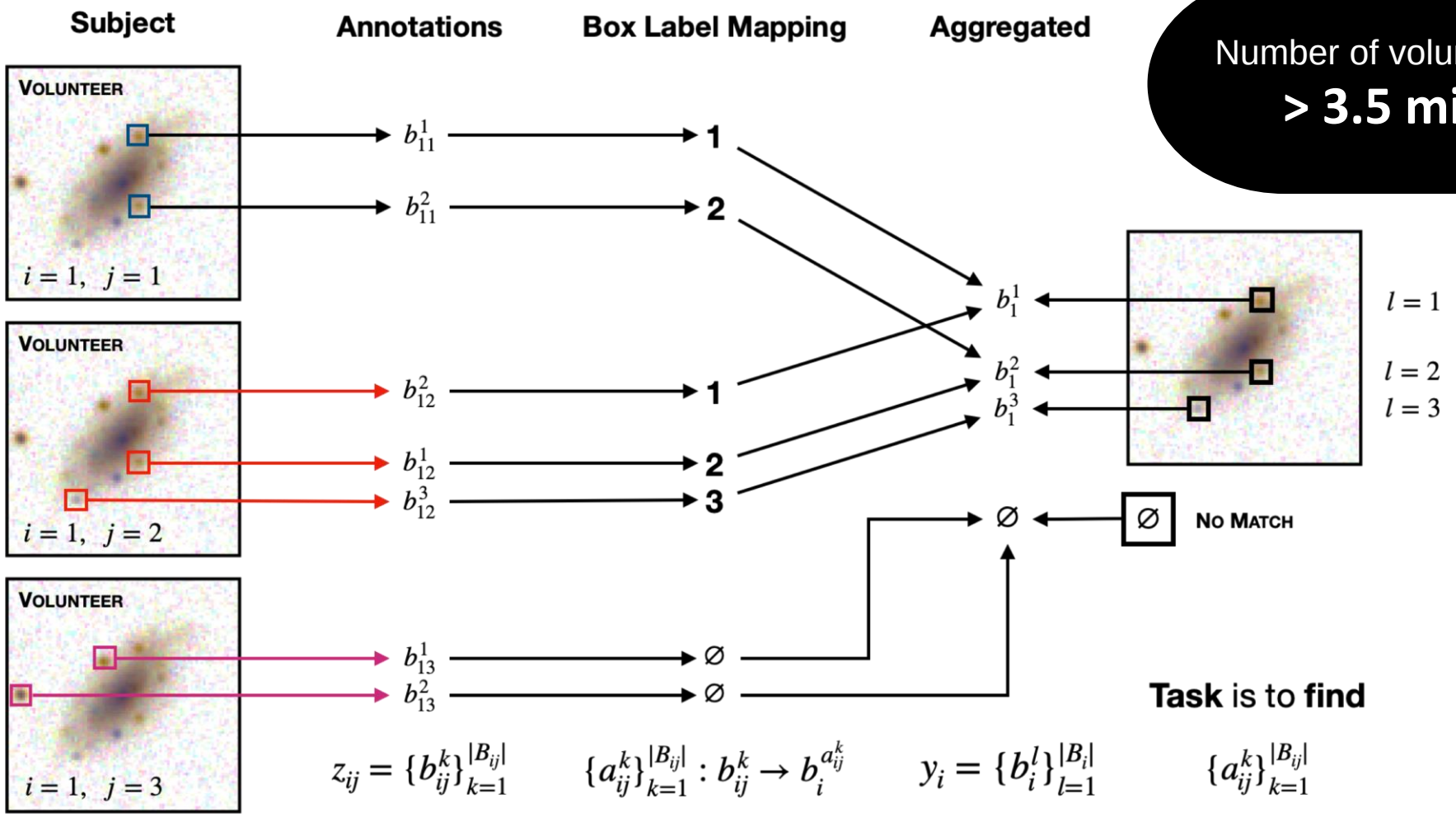

Number of volunteer clicks
> 3.5 million

Task is to **find**

github.com/ou-astrophysics/BoxAggregator

arXiv Dickinson et al (2022) - arxiv.org/abs/2210.03684

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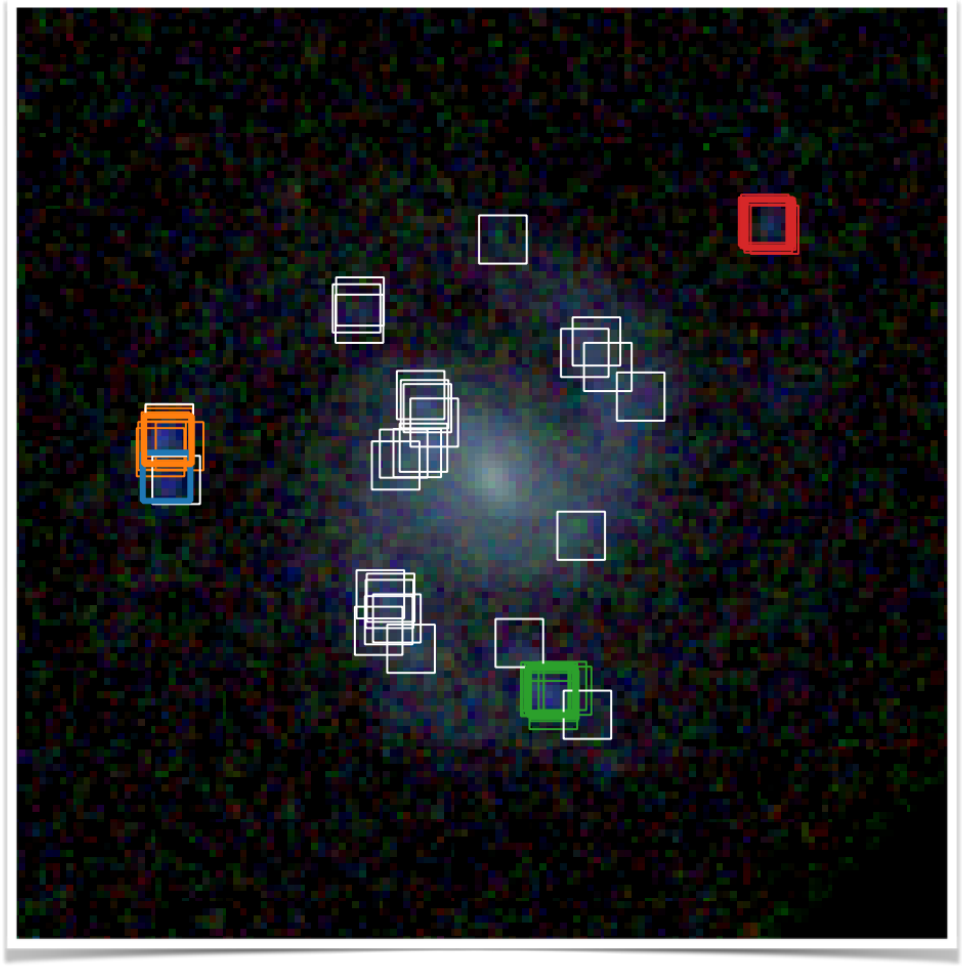

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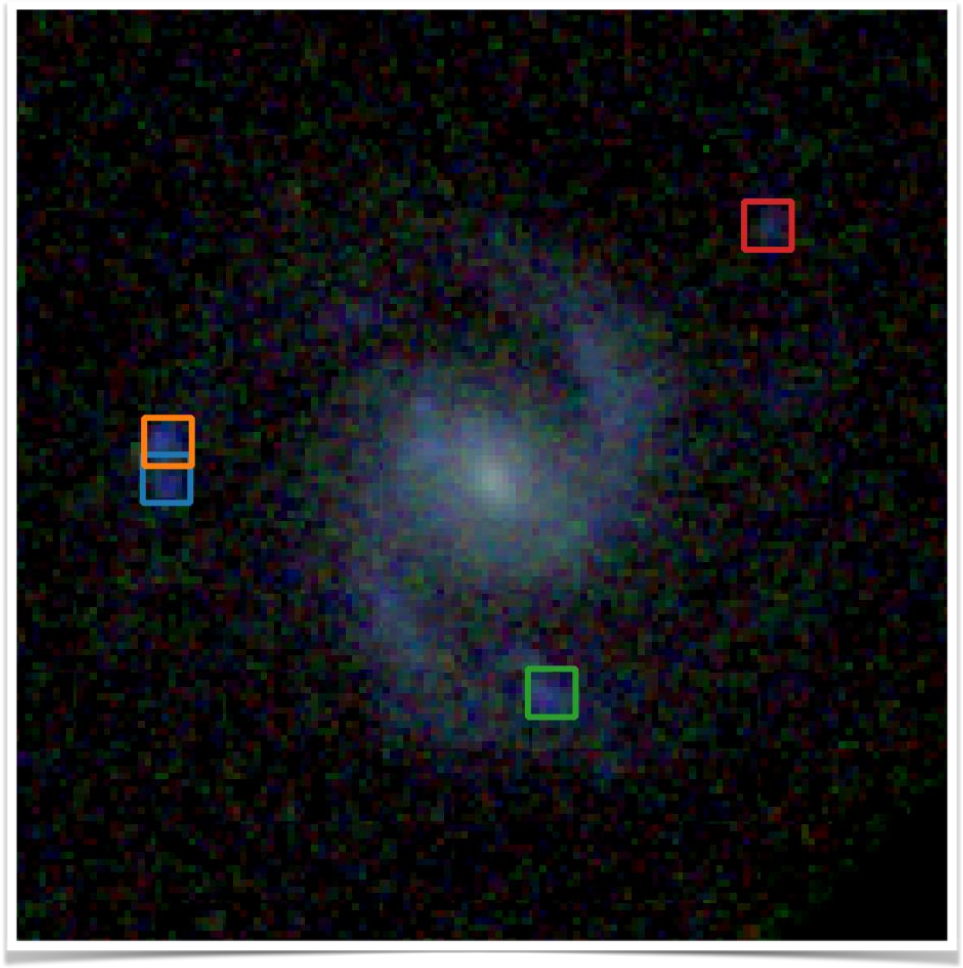

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Number of clumpy galaxies:

~35,000

Number of potential clumps:

~100,000

First catalogue released!

Adams et al (2022) - arxiv.org/abs/2201.06581

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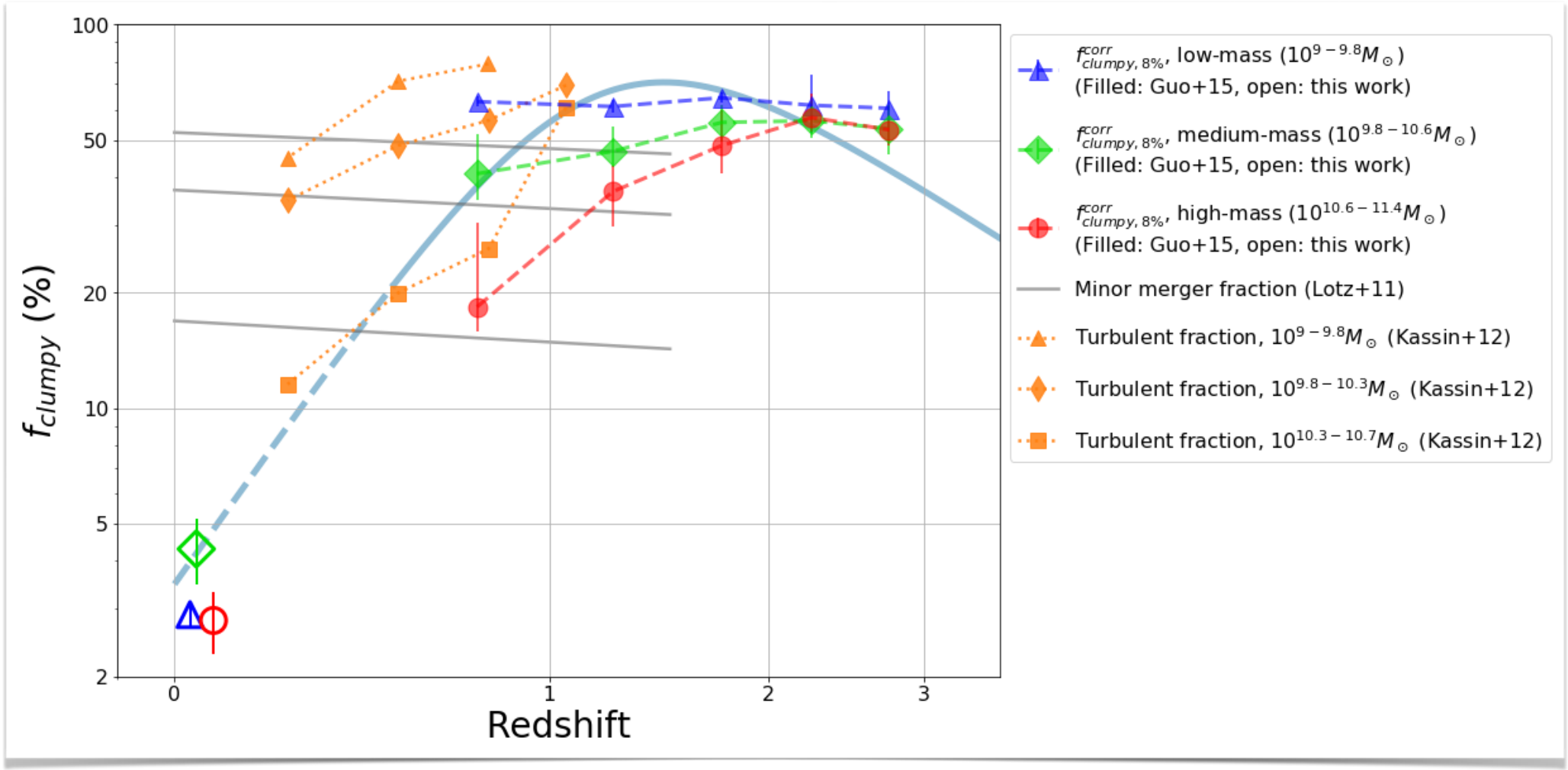

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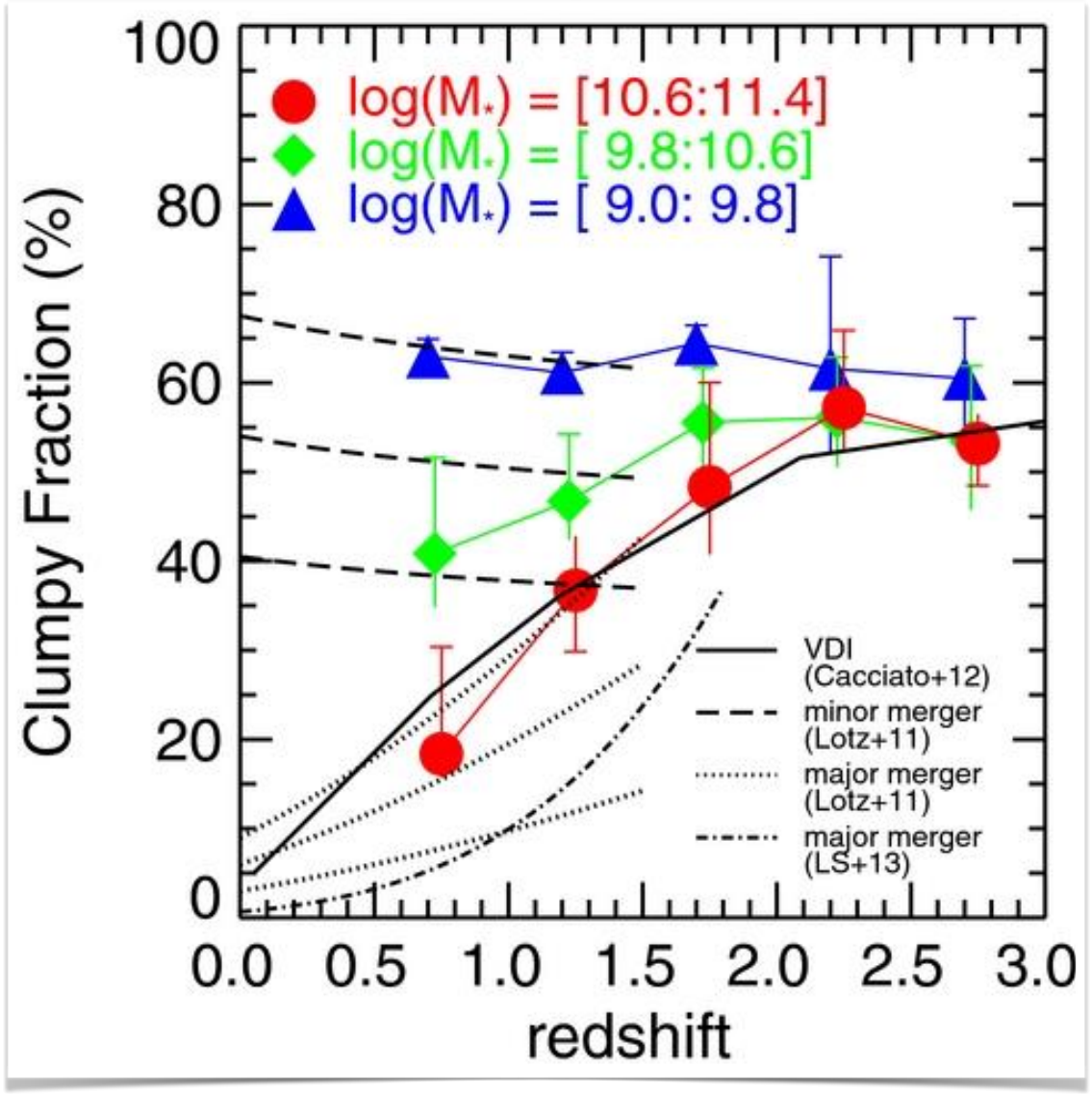

Guo et al. (2015)

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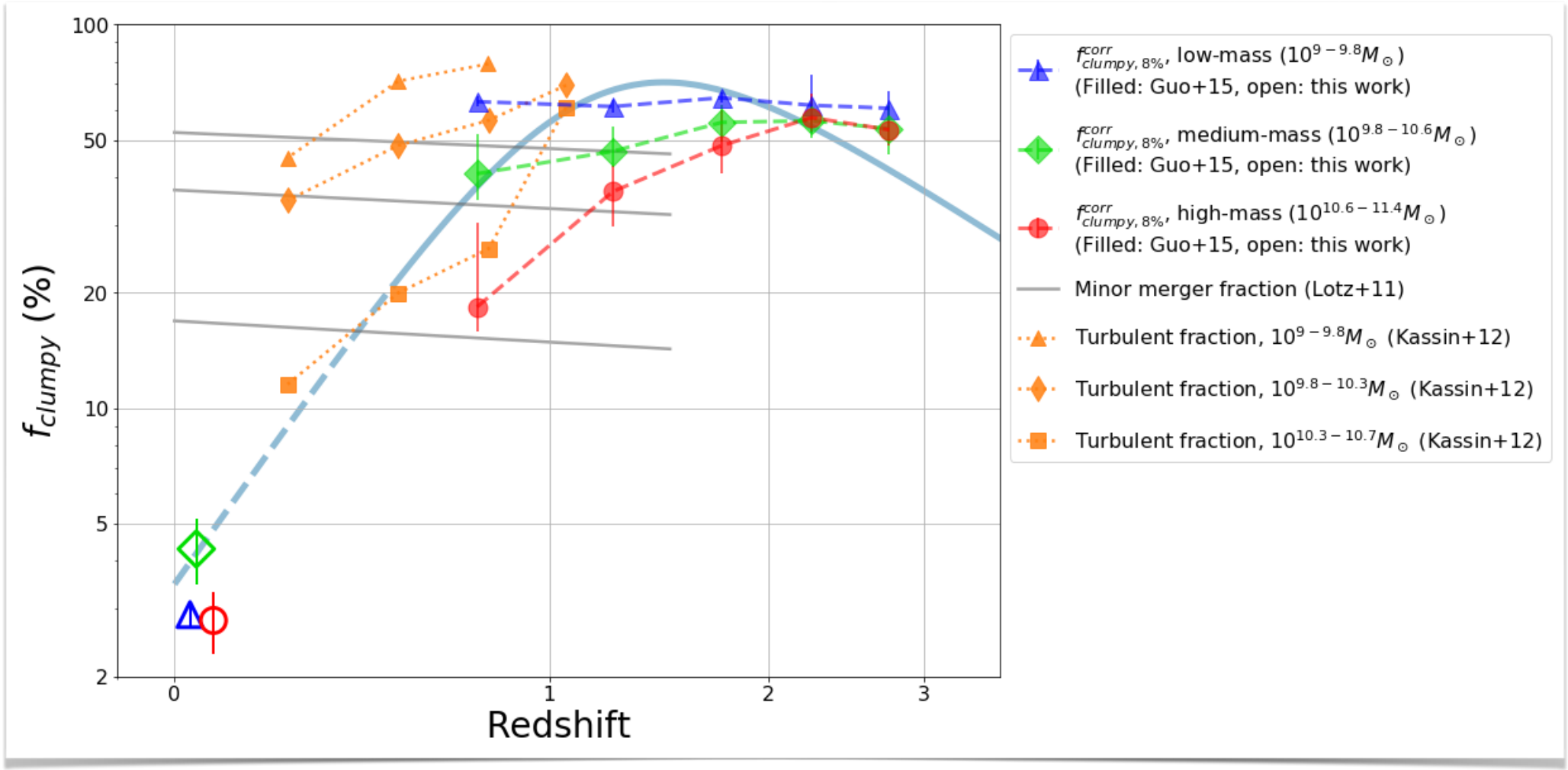

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The Deep Learning Approach

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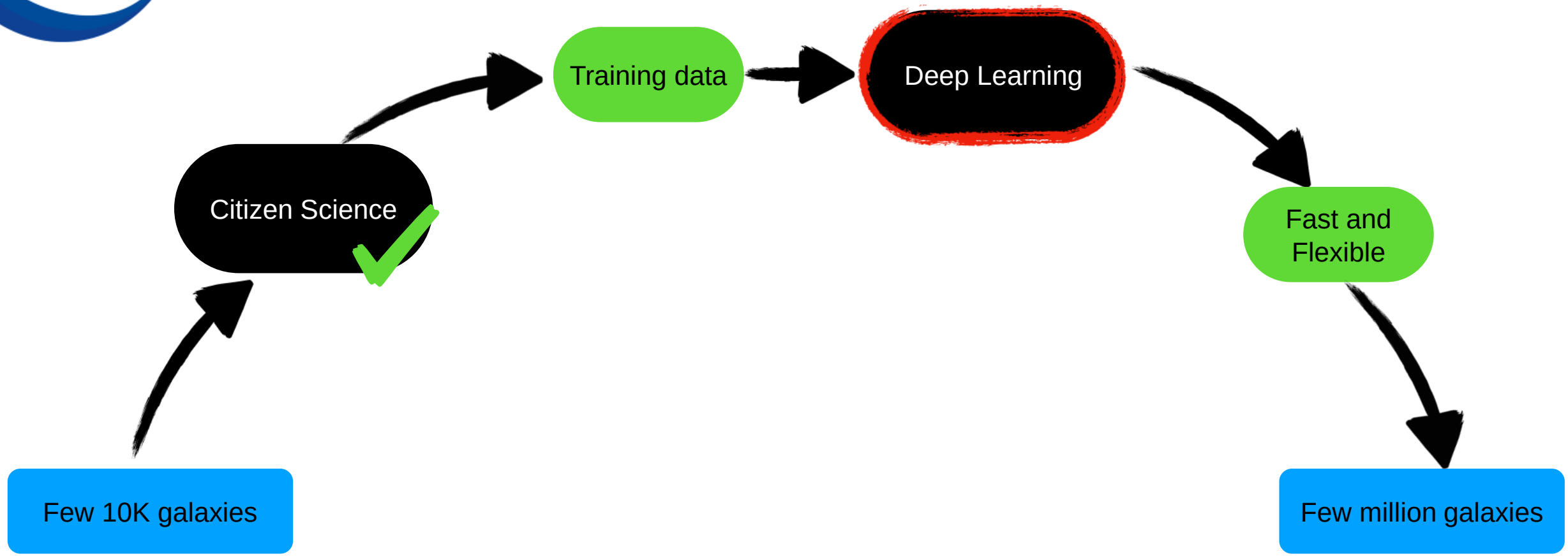

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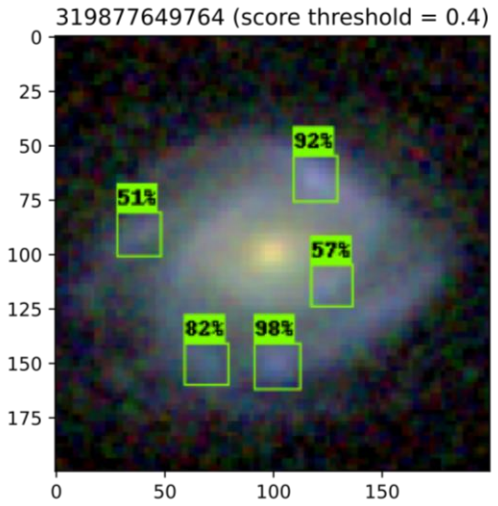
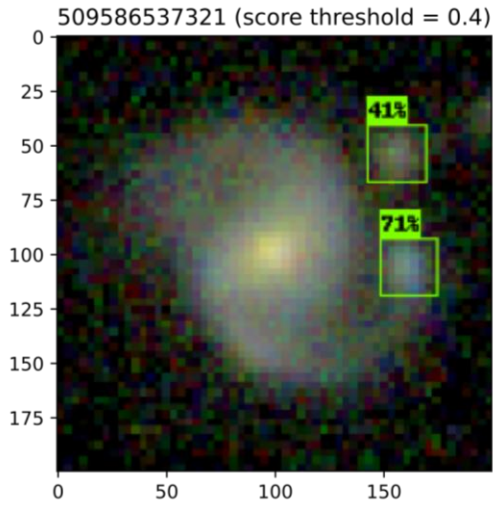
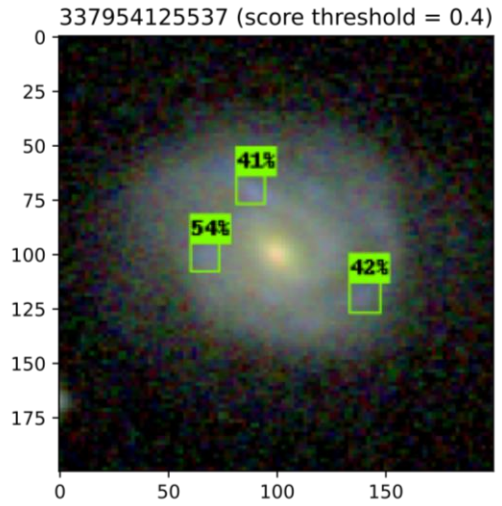
Generic Deep Learning model finds

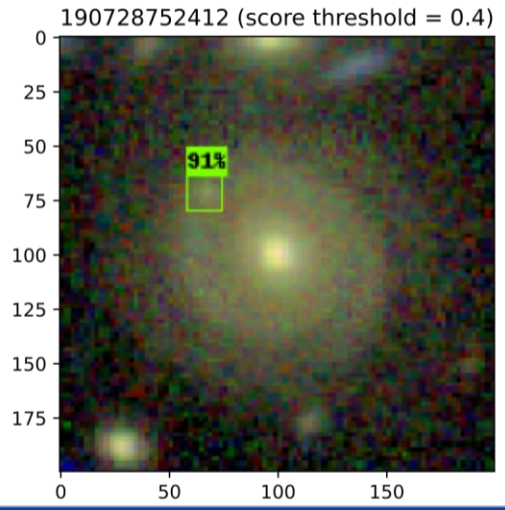
four times

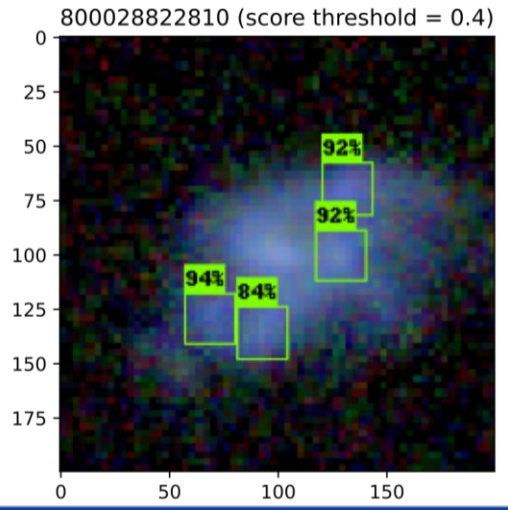
as many clumps as Clump Scout volunteers!

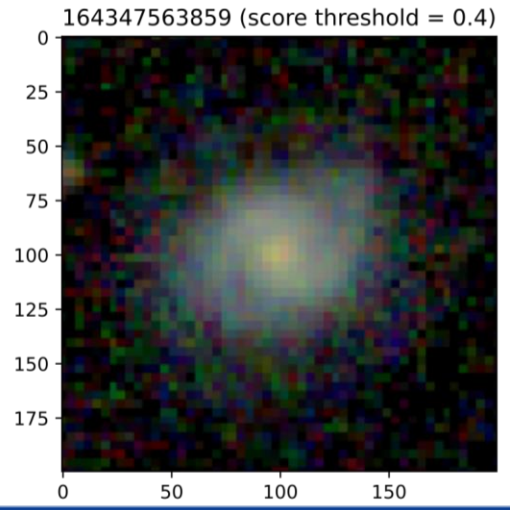


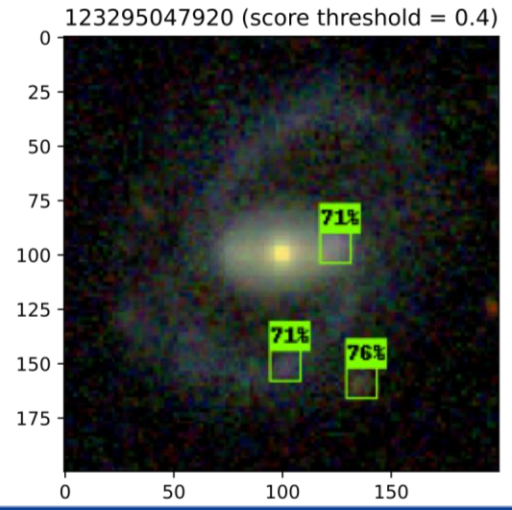












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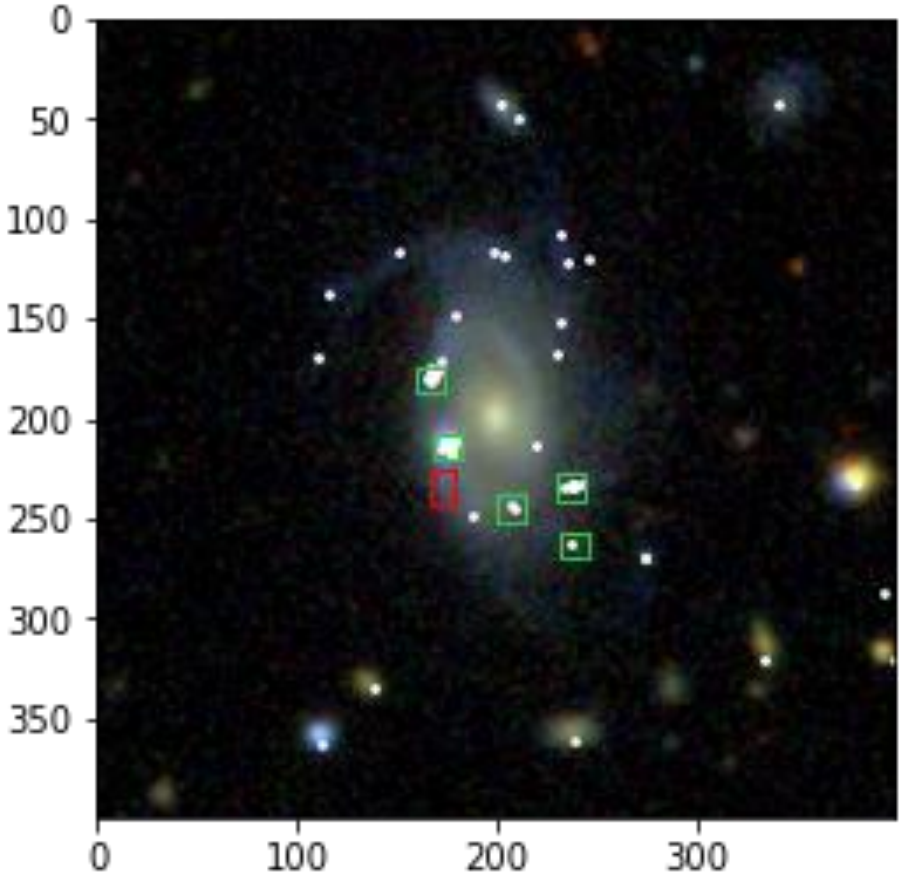

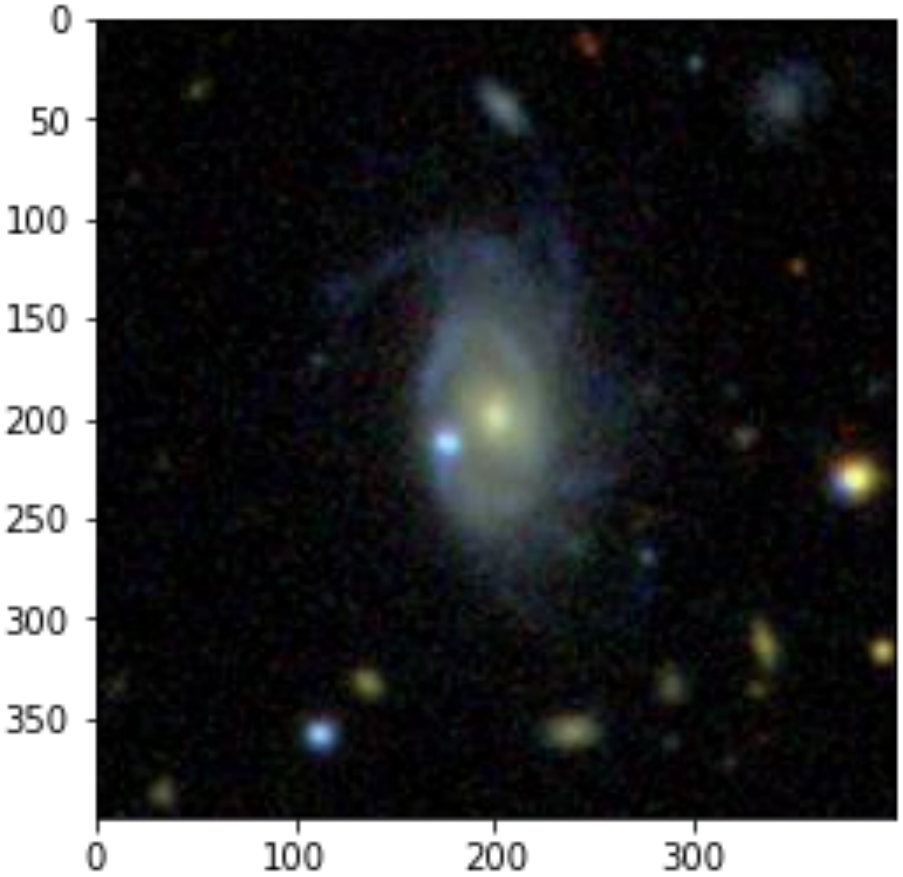

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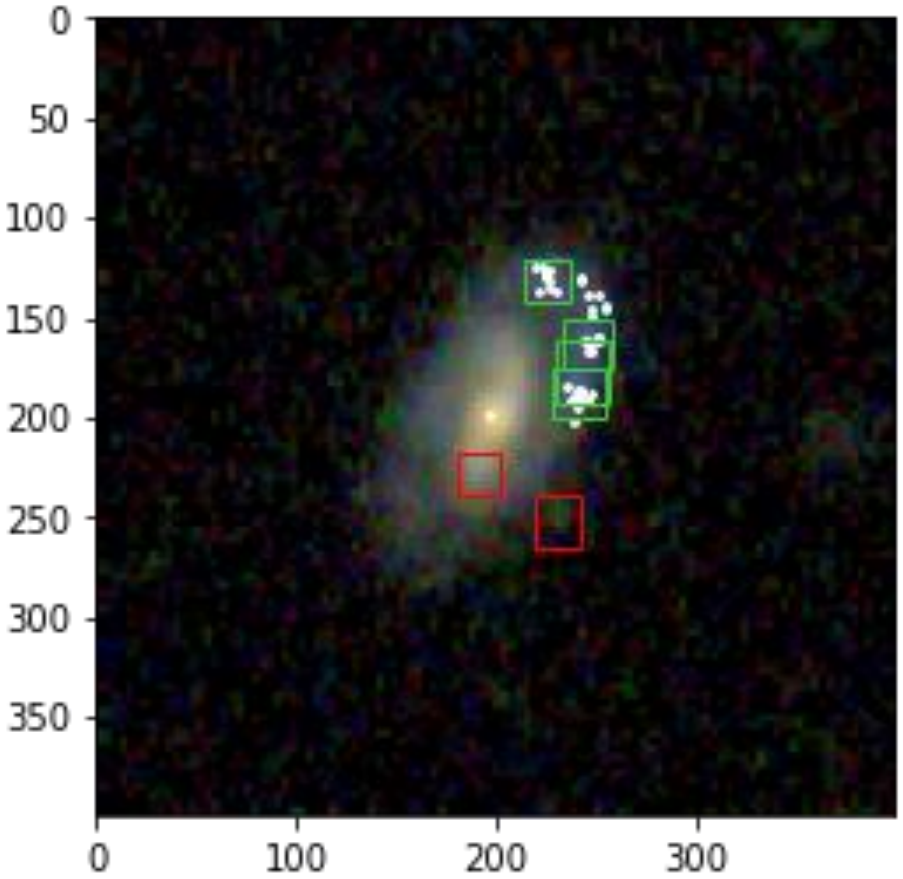

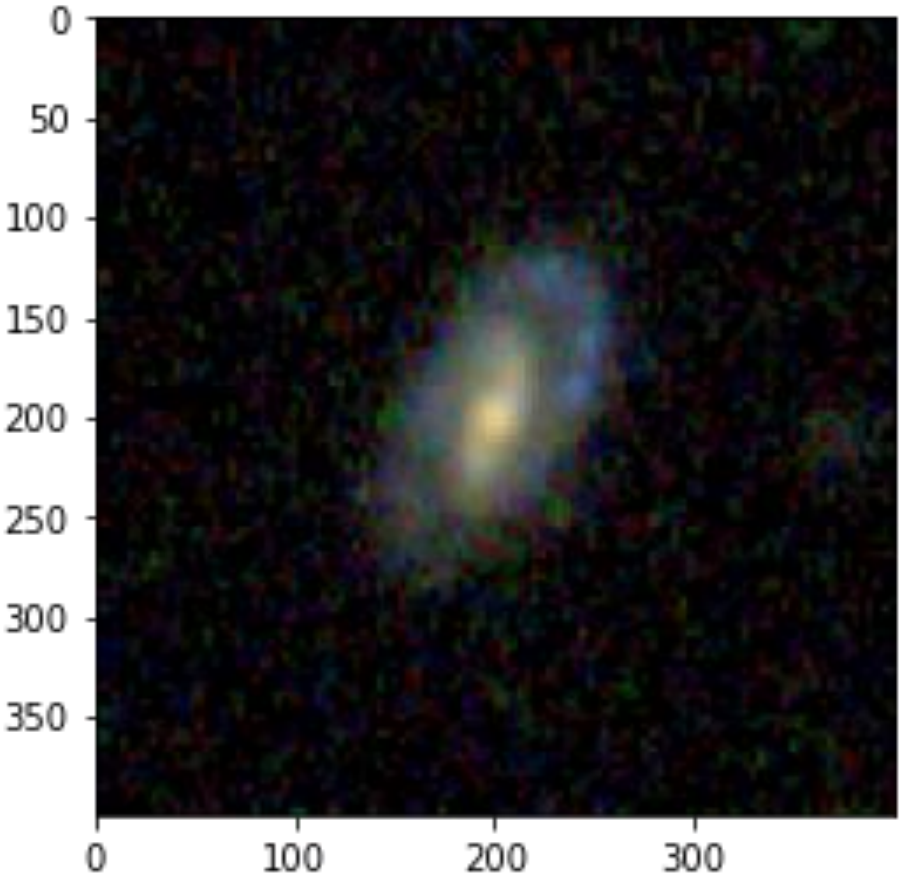

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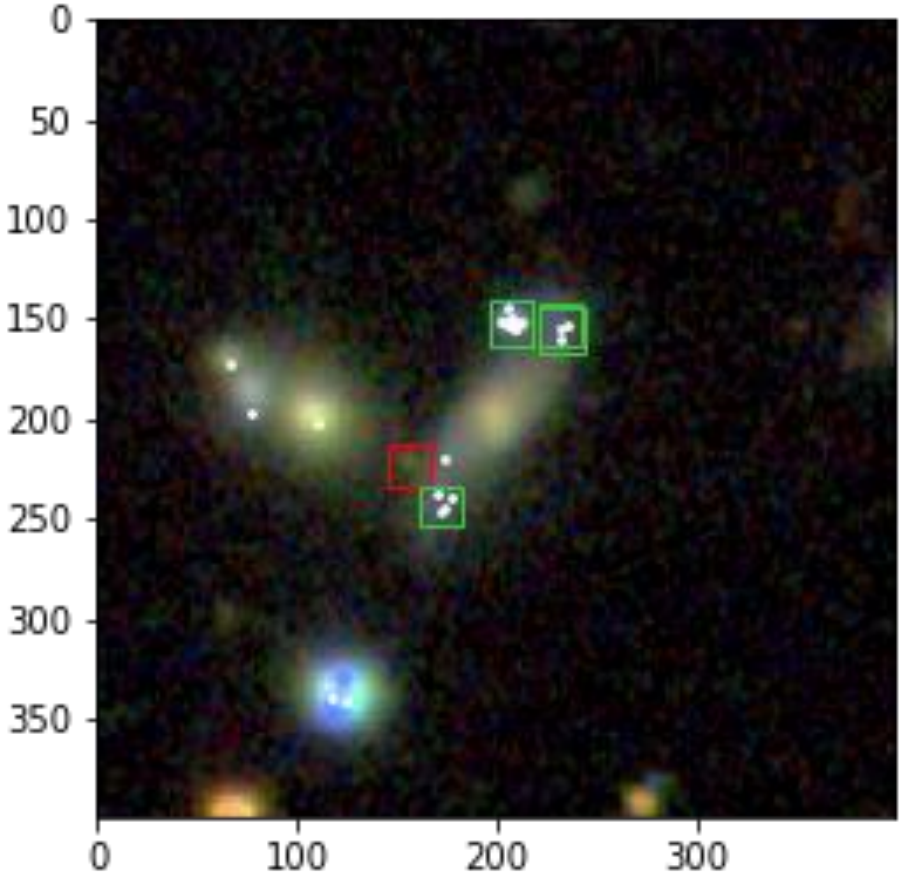

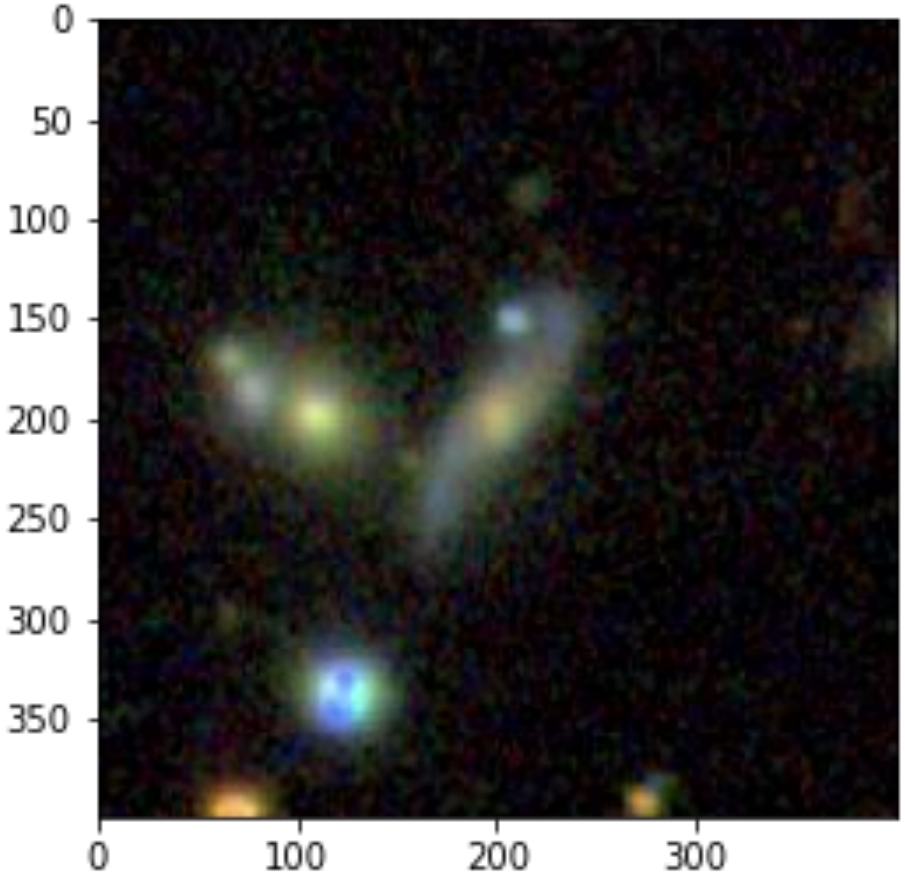

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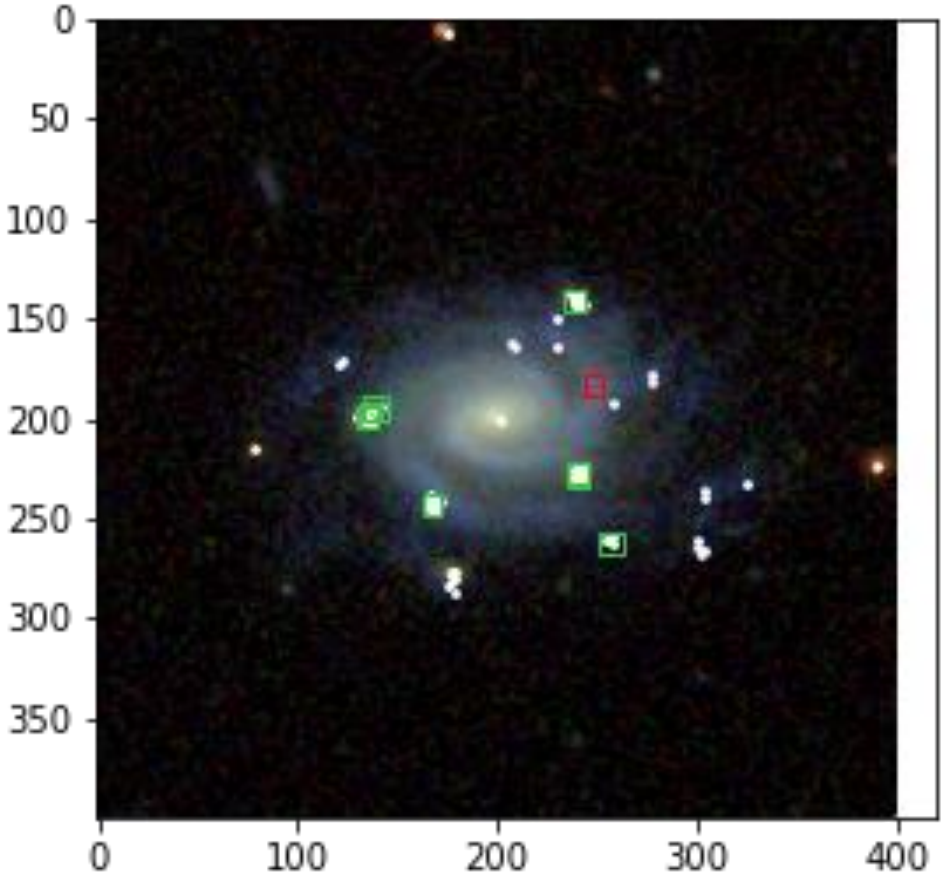

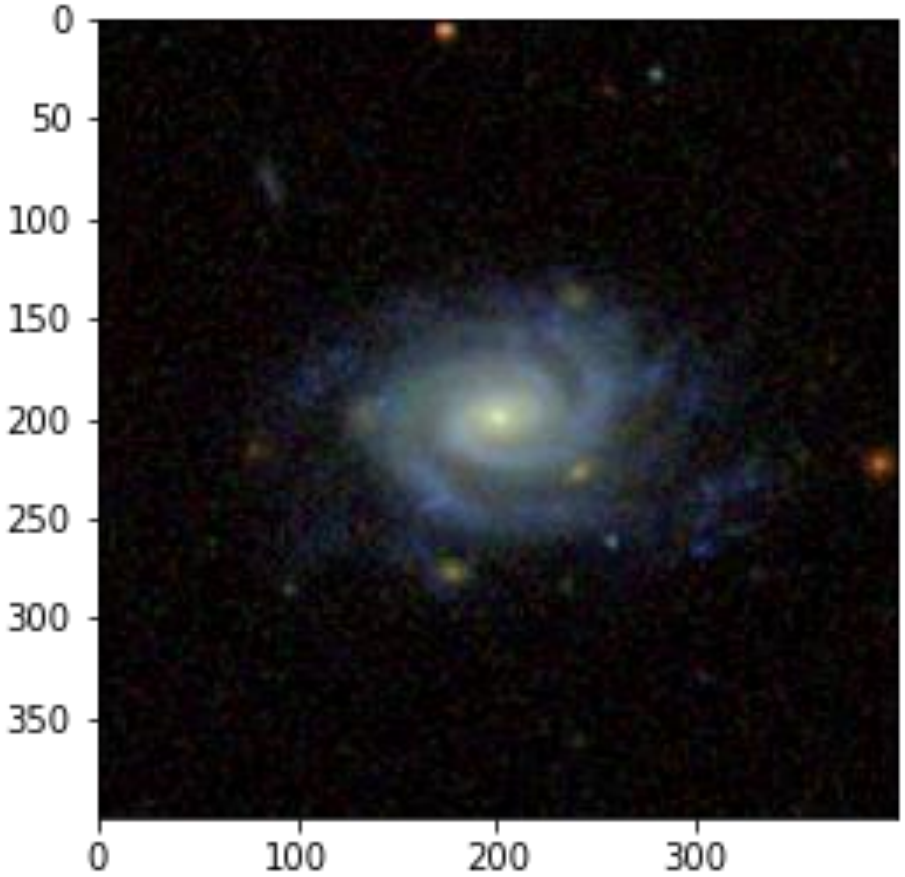

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Number of Galaxies inspected:
~80,000

Number of clumpy galaxies:
~35,000

Number of potential clumps:
~100,000

Two papers now out!

First catalogue released!

ML Model Trained!

Third paper in prep!

github.com/ou-astrophysics/BoxAggregator

Adams et al (2022) - arxiv.org/abs/2201.06581

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European Science Cluster of Astronomy & Particle physics ESFRI research Infrastructures

Thanks!

ESCAPE
European Science Cluster of Astronomy & Particle physics ESFRI research Infrastructures

ESCAPE to the Future
25-26 October 2022
Brussels, Belgium

EOSC Future

Managing Citizen Science from ESAP

James Pearson, Hugh Dickinson

ESCAPE ESAP | ESFRI Science Analysis Platform ⟷ ZOONIVERSE

The Open University

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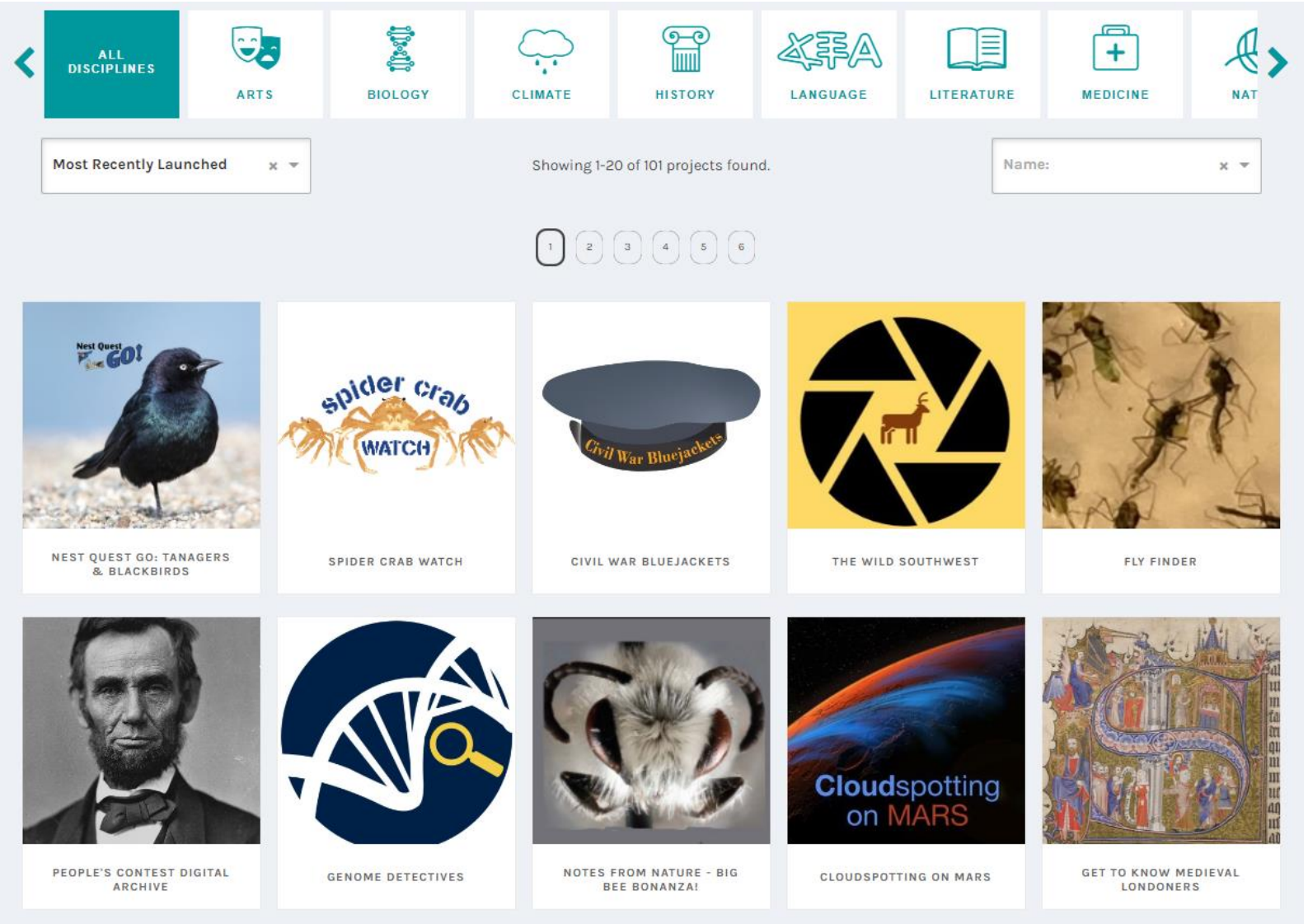
Zooniverse Projects



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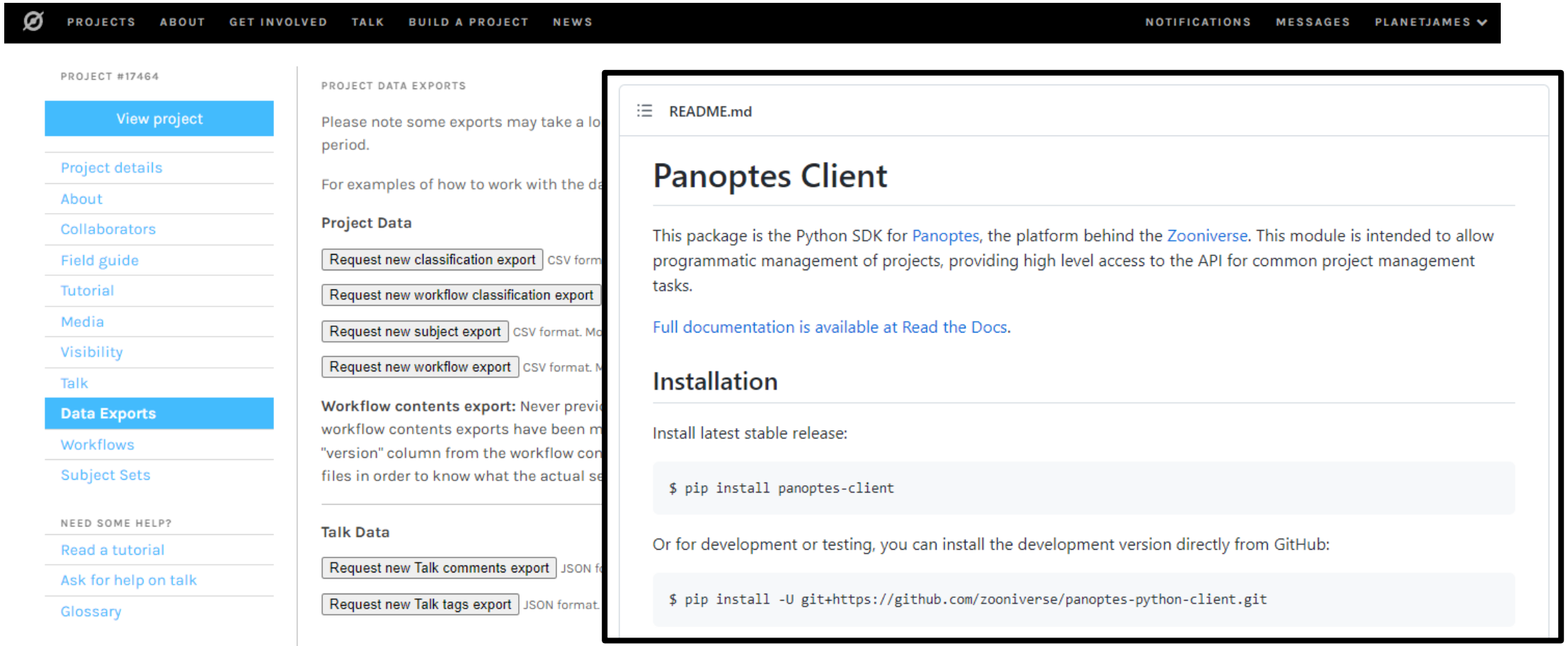
Zooniverse Projects



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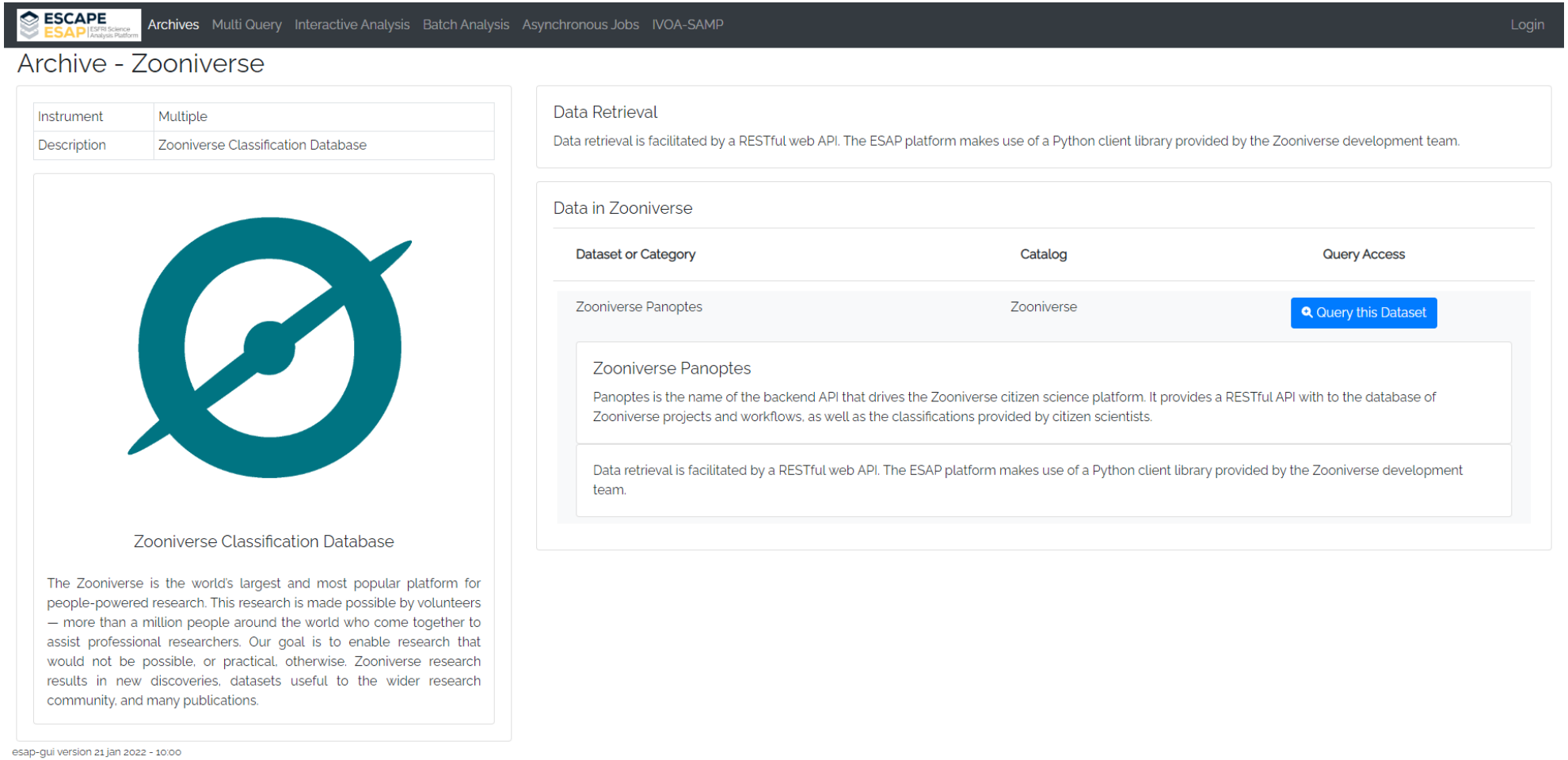
ESFRI Science Analysis Platform (ESAP)



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Managing Citizen Science from ESAP

- Aim:
  - Develop a suite of tutorial workflows and material demonstrating the creation and management of Zooniverse citizen science projects through ESAP.
- Notebooks and documentary materials demonstrate:
  - **Advanced Zooniverse project building** for subject creation and upload, attaching metadata, and providing training and feedback to volunteers,
  - Integrating with the Zooniverse's Caesar engine for **aggregation of results and advanced subject retirement rules**.
  - Accessing the **ESAP Shopping Basket** to download data for aggregation.
  - Integrating Zooniverse projects with existing **deep learning frameworks,** including pre-filtering subjects and creating detailed subject retirement rules.
  - Setting up an **active learning framework** to simultaneously improve both deep learning performance and the experience of volunteers.

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Current Progress

Zooniverse: Advanced Project Building

Description: Demonstrates techniques for advanced Zooniverse project management using Python.
Link: https://git.astron.nl/astron-sdc/escape-wp5/workflows/zooniver
Author: Hugh Dickinson
Runtime Platform: Python
Keywords: jupyter-noteb

Zooniverse: Integrating Machine Learning

Description: Demonstrates techniques to integrate your Zooniverse project with machine learning.
Link: https://git.astron.nl/astron-sdc/escape-
ine-learning

- Tutorial Jupyter notebooks.
- Recorded walkthroughs of these tutorials.
- Speech-to-text documentation of these recordings, for greater accessibility.

Zooniverse: Advanced Aggregation with Caesar

Description: Demonstrates how to use the Zooniverse Caesar engine to aggregate your data.
Link: https://git.astron.nl/astron-sdc/escape-wp5/workflows/zooniverse-advanced-aggregation-with-caesar.git
Author: Hugh Dickinson
Runtime Platform: Python
Keywords: jupyter-notebook

Zooniverse Muon Hunters

Description: Shopping Cart and Zooniverse Example
Link: https://git.astron.nl/astron-sdc/escape-wp5/workflows/muon-hunters-example
Author:
Runtime Platform: Python
Keywords: jupyter-notebook

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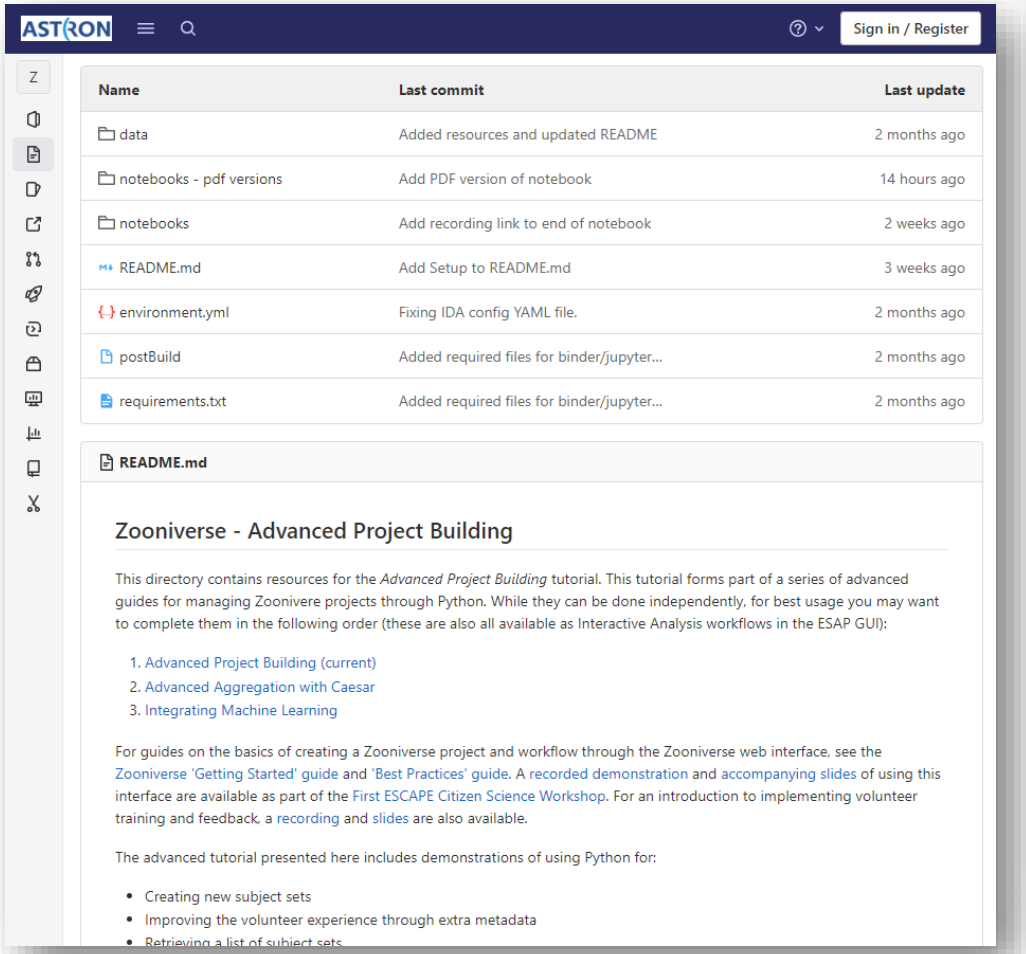
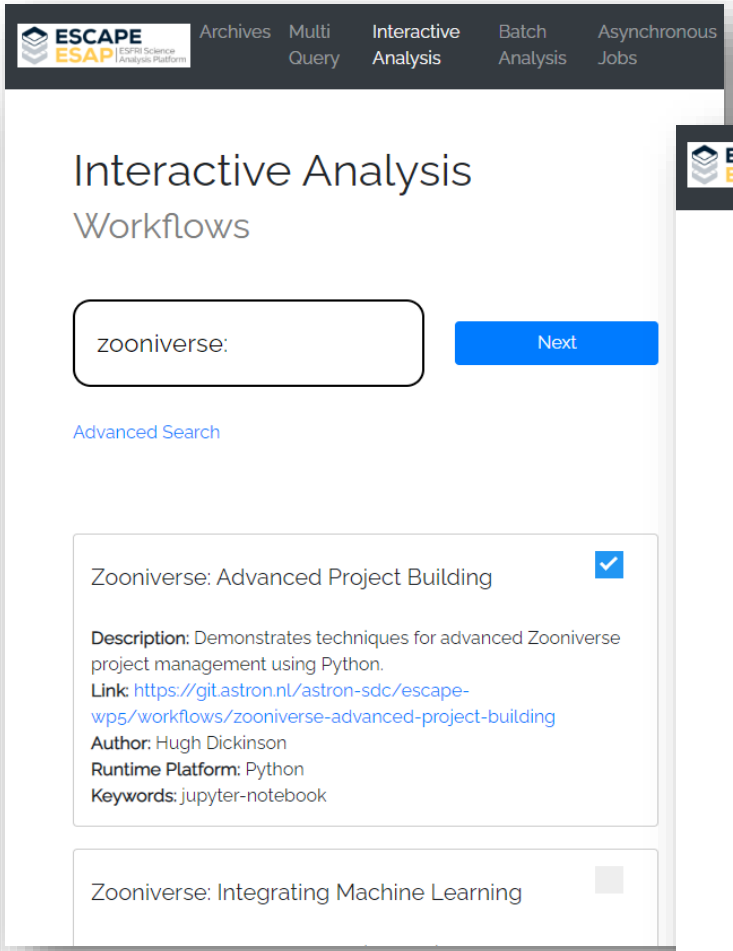
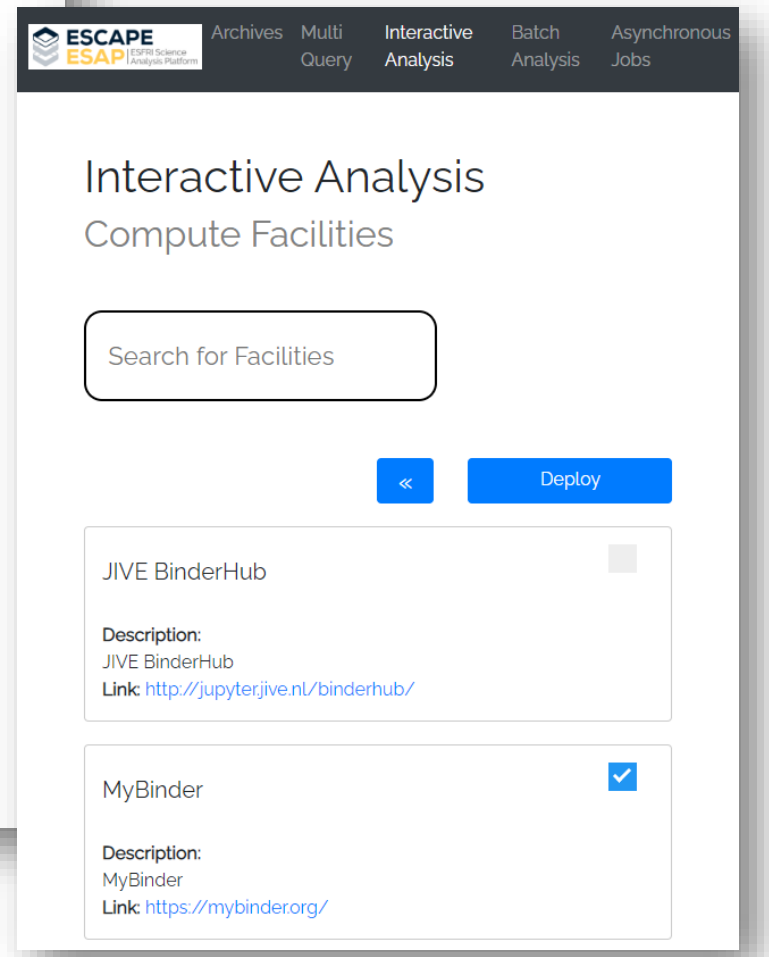
Current Progress







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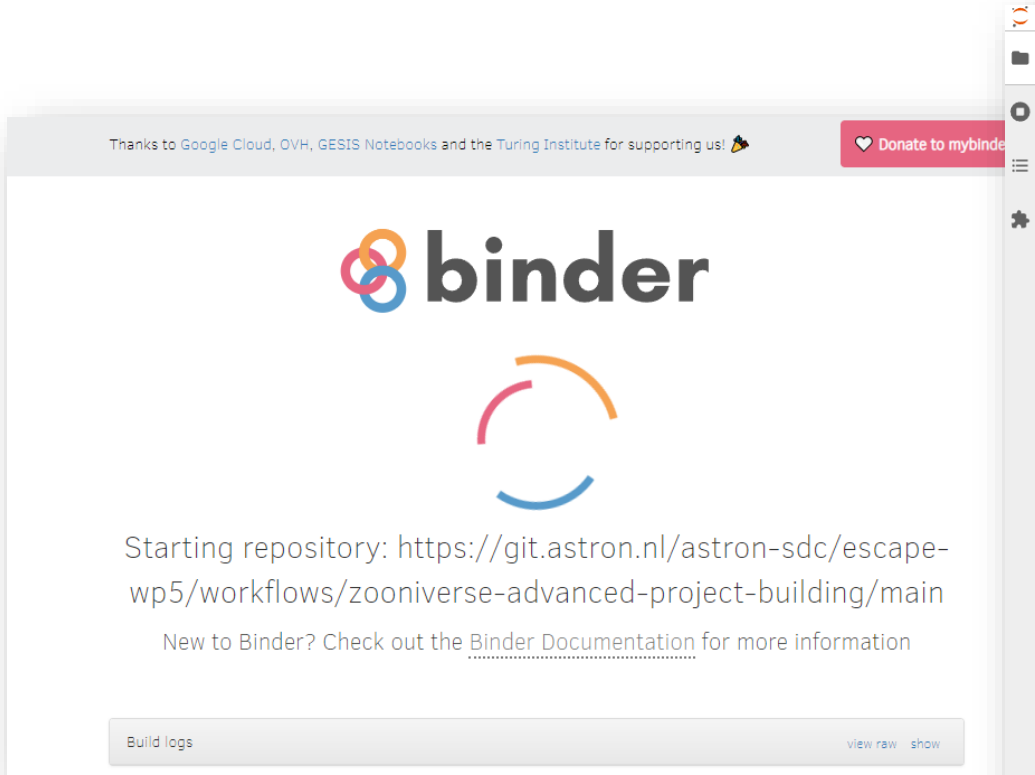
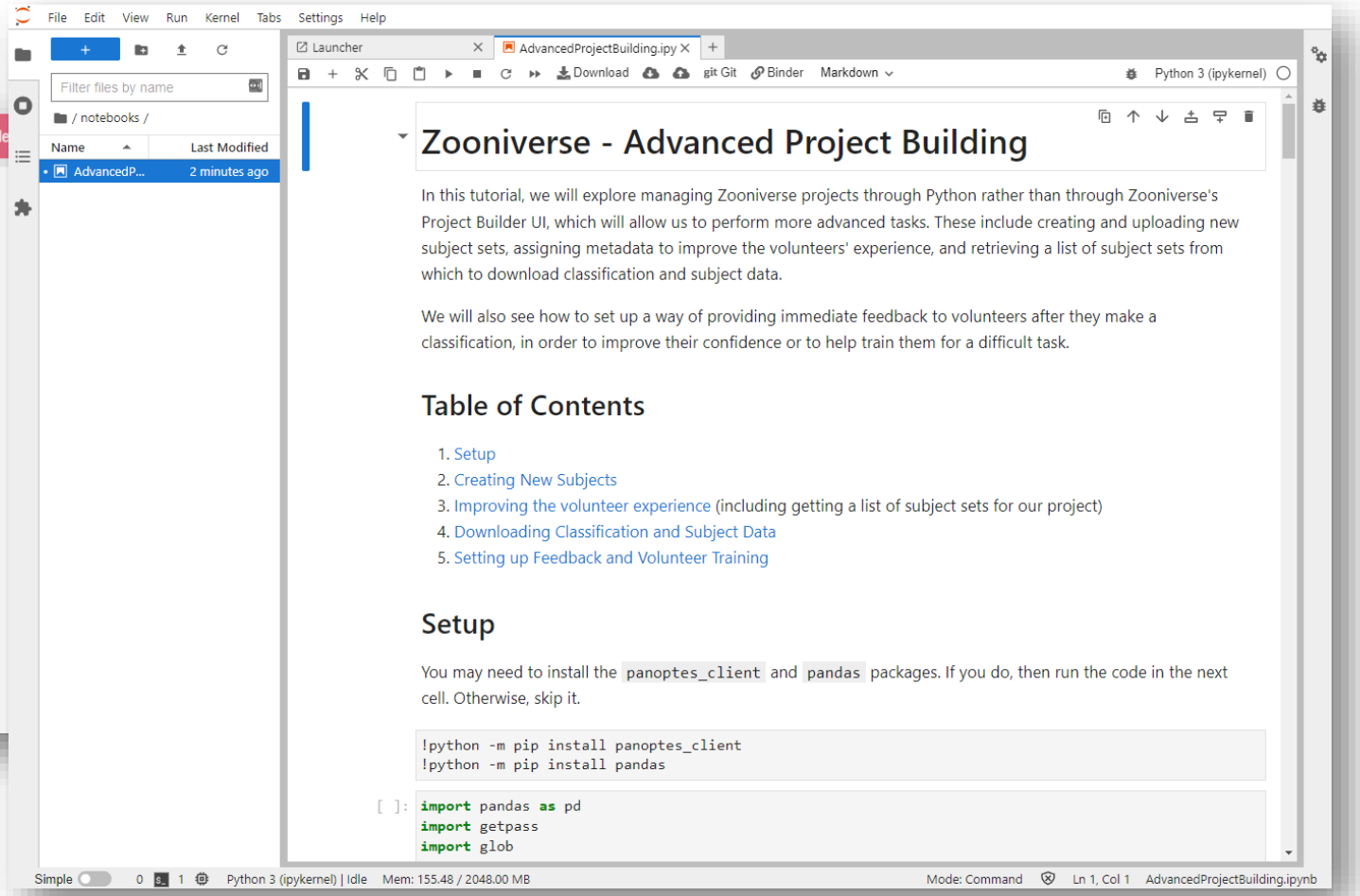
Current Progress





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What's Next?

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What's Next?

```
In [2]: import ipyaladin.aladin_widget as ipyal

In [3]: aladin=ipyal.Aladin(target='NGC 2976', fov=1.0, survey='P/SDSS9/color')
        aladin
```


```
In [ ]:

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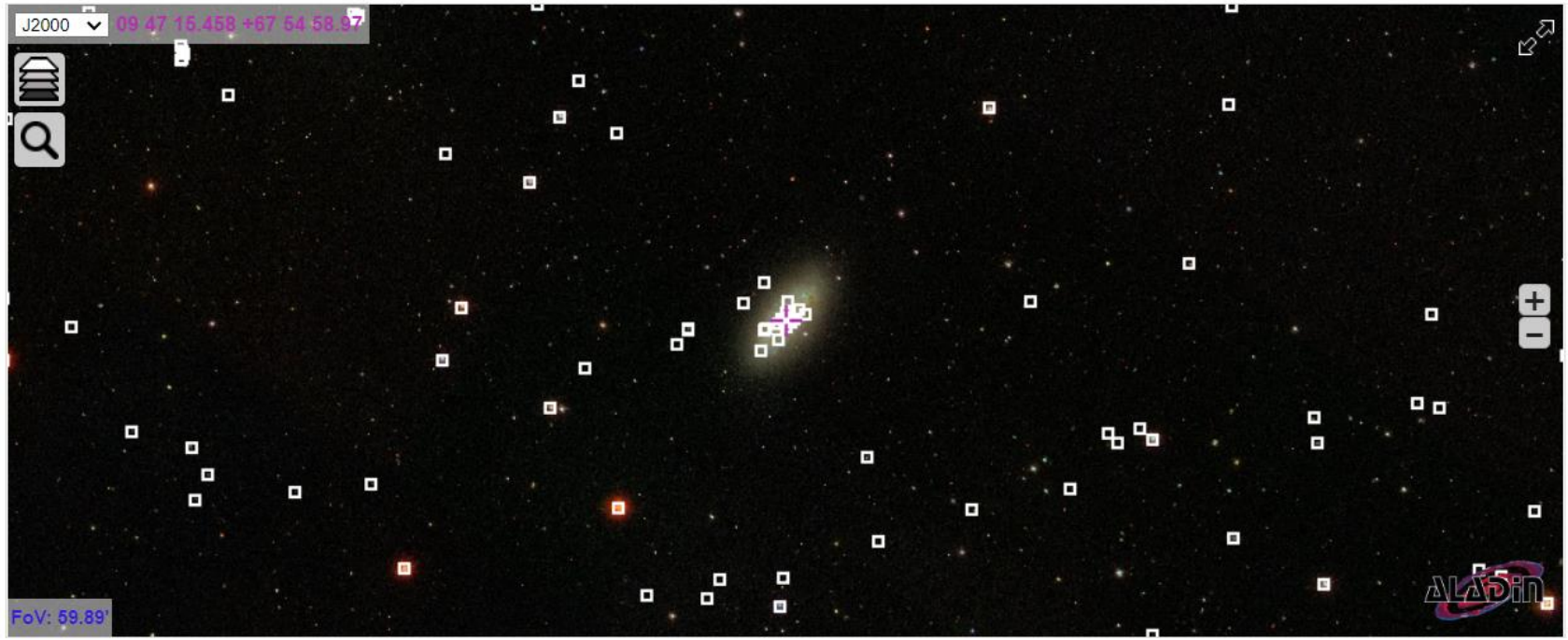


```
In [4]: from panoptes_client import GalaxyZoo
        table = GalaxyZoo.query_region('NGC 2976', radius='1 degree')
        aladin.add_table(table)
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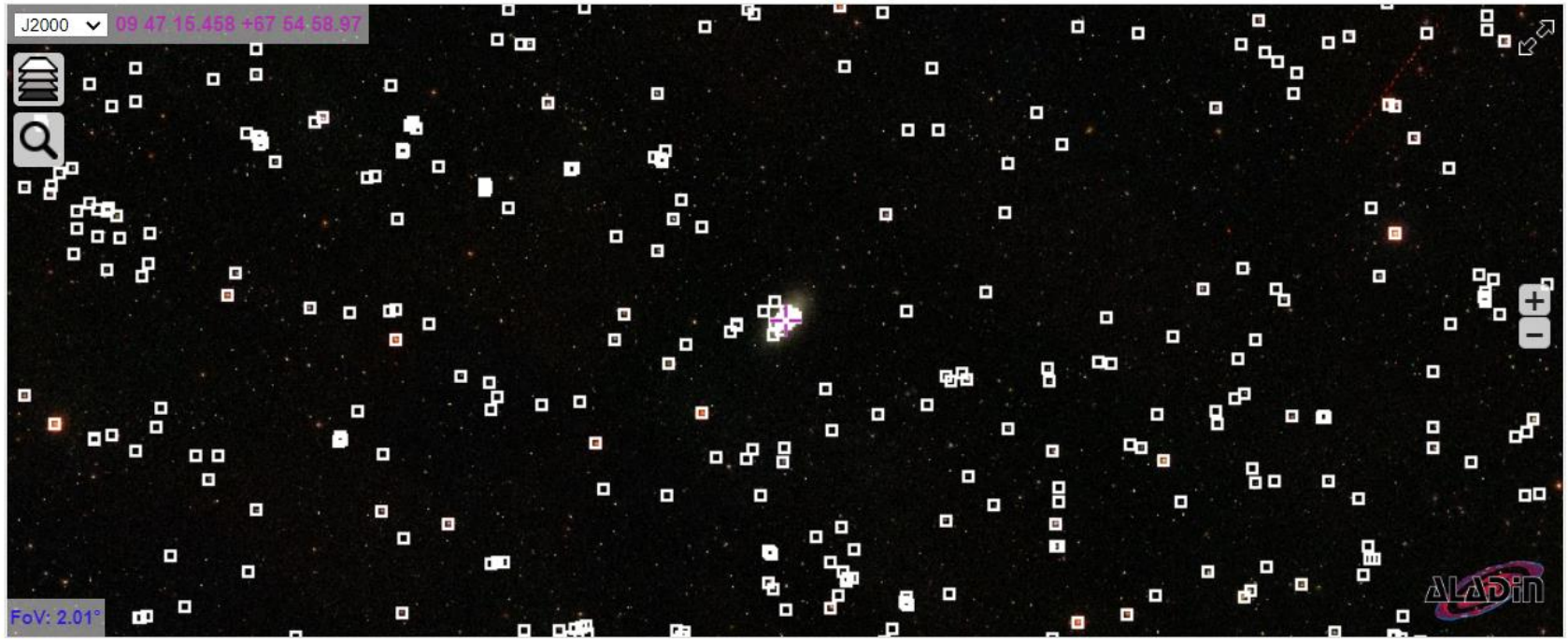


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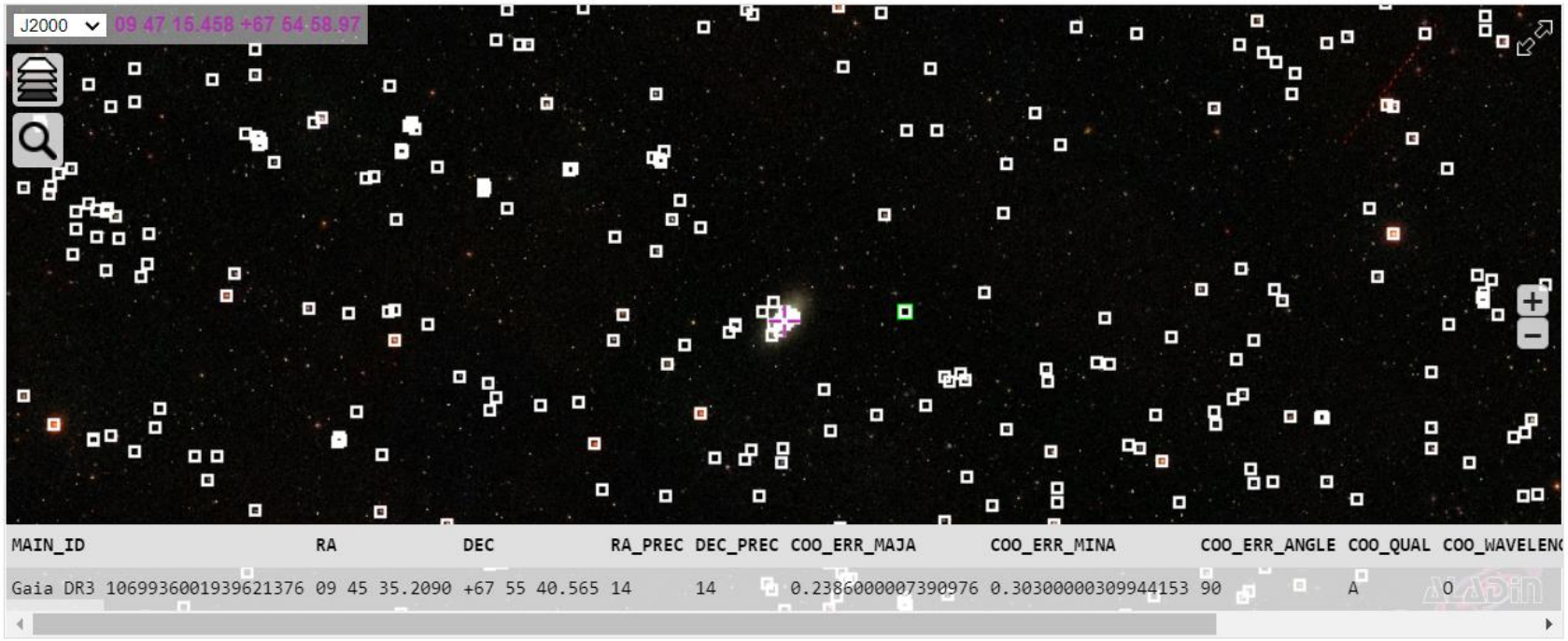

MAIN_ID	RA	DEC	RA_PREC	DEC_PREC	COO_ERR_MAJA	COO_ERR_MINA	COO_ERR_ANGLE	COO_QUAL	COO_WAVELEN
Gaia DR3 1069936001939621376	09 45 35.2090	+67 55 40.565	14	14	0.2386000007390976	0.30300000309944153	90	A	O

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In summary, this work allows:

- professional scientists to combine the powers of both ESAP and Citizen Science for their research,
- volunteers to engage even further with this research and with astronomy in general.

Thanks for listening!

Summary

- The Zooniverse platform for people-powered research gives everyone the opportunity to contribute meaningfully to scientific discovery.
- To aid researchers, we have developed a suite of easy-to-use workflows and material for managing Zooniverse projects through ESAP, demonstrating:
  - **advanced project building** techniques,
  - using Zooniverse's **Caesar engine for aggregation** of results and **advanced subject retirement rules**,
  - accessing the **ESAP Shopping Basket**,
  - integrating with **deep learning models** to make projects more efficient, including setting up an **active learning cycle**.
- Recorded walkthroughs of these notebooks, with speech-to-text documentation for greater accessibility, are available.
- We hope to develop a **Virtual Observatory (VO) tool** for seamless data exploration of galaxies in the VO with labelled Galaxy Zoo morphologies.

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Where next for citizen science in EOSC?

- What limits the take up of crowdsourced data mining in EOSC?
  - Trust in the reliability? Skills at aggregating the data? Temptation just to pay Amazon MT?
  - Seeing science results will help
  - Seeing it work up close will help
  - Build multi-disciplinary exemplar experiments following ESCAPE model
  - Create worked examples of plug-and-play notebooks for running projects in EOSC
- Improve integration with other EOSC services, eg VO, AAI, virtuous circle with ESAP ML (for large projects)
- Open data standards in FAIRsharing.org?
- Dedicated EOSC task force for citizen science?
- Funding for ESAP platform for multi/inter-disciplinary citizen science?

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60 SECOND ADVENTURES IN ARTIFICIAL INTELLIGENCE