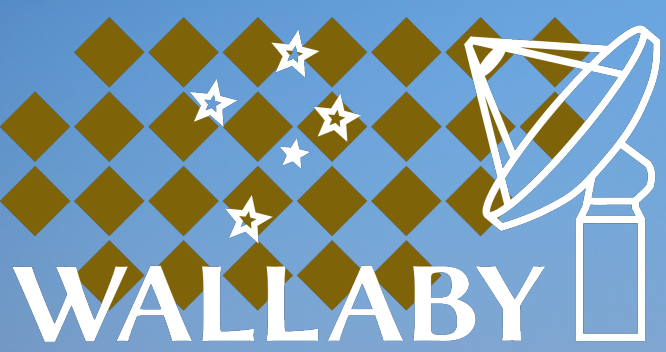


Coventry UK





Dark Galaxies in the WALLABY Survey



Jeremy Mould

Annual Centre for Dark Matter Meeting



From Wikipedia, the free encyclopedia

- A **dark galaxy** is a hypothesized [galaxy](#) with no (or very few) stars. They received their name because they have no visible stars^[1] but may be detectable if they contain significant amounts of gas. Astronomers have long theorized the existence of dark galaxies, but there are no confirmed examples to date.^[2] Dark galaxies are distinct from intergalactic [gas clouds](#) caused by [galactic tidal interactions](#), since these gas clouds do not contain [dark matter](#), so they do not technically qualify as galaxies. Distinguishing between intergalactic gas clouds and galaxies is difficult; most candidate dark galaxies turn out to be tidal gas clouds.^[3] The best candidate dark galaxies to date include HI1225+01,^[4] AGC229385,^[5] and numerous gas clouds detected in studies of [quasars](#).

WALLABY

- A survey of the Southern Hemisphere, 2023-2028 in the spin flip transition of neutral hydrogen at 21 cm
- 36 ASKAP telescopes with Phased Array Feeds
- 30 square degree field,
30 arcsec beam
- Pilot survey of 300 sq deg completed
this year

Team leaders: Lister Staveley-Smith
Barbara Catinella

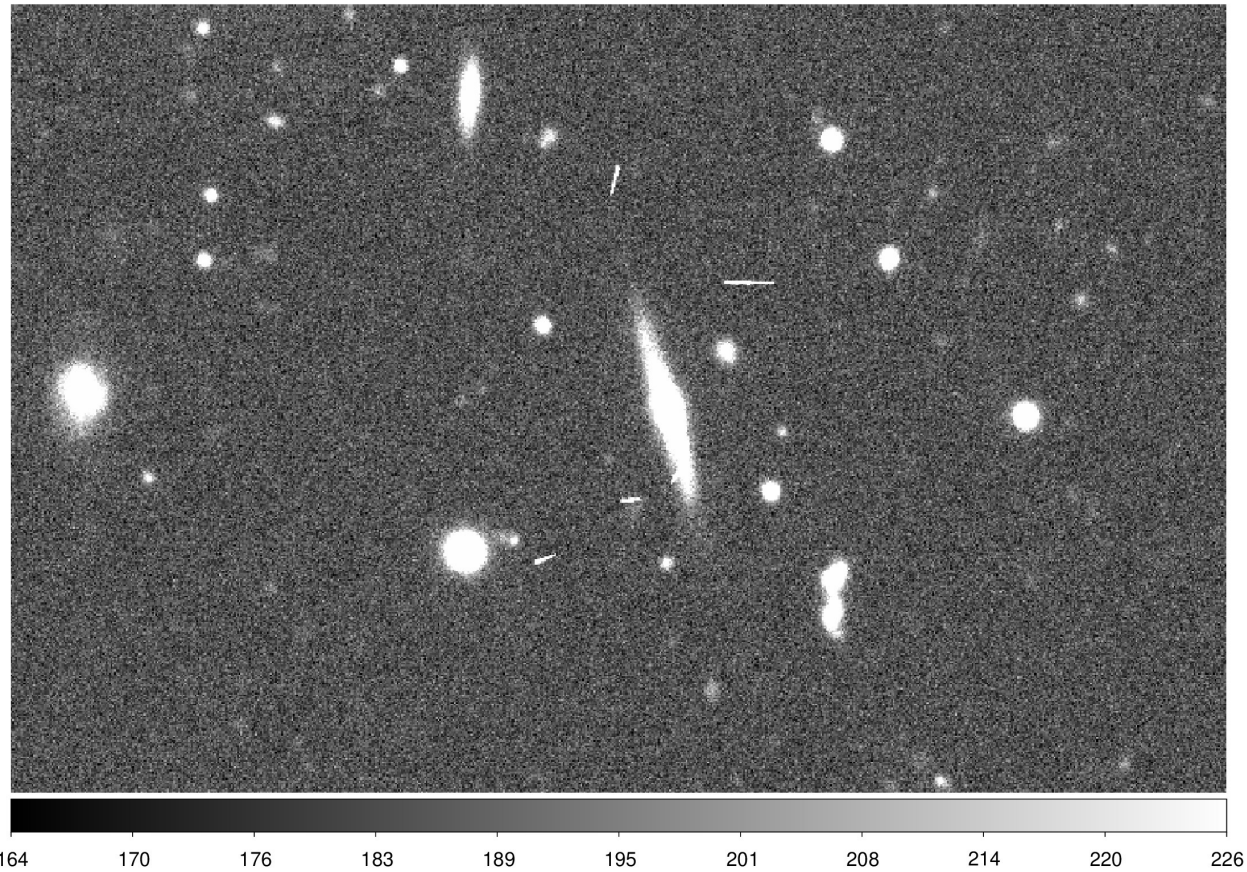


The Australian SKA looks like this,
not like ASKAP

Wajarri Yamaji Country



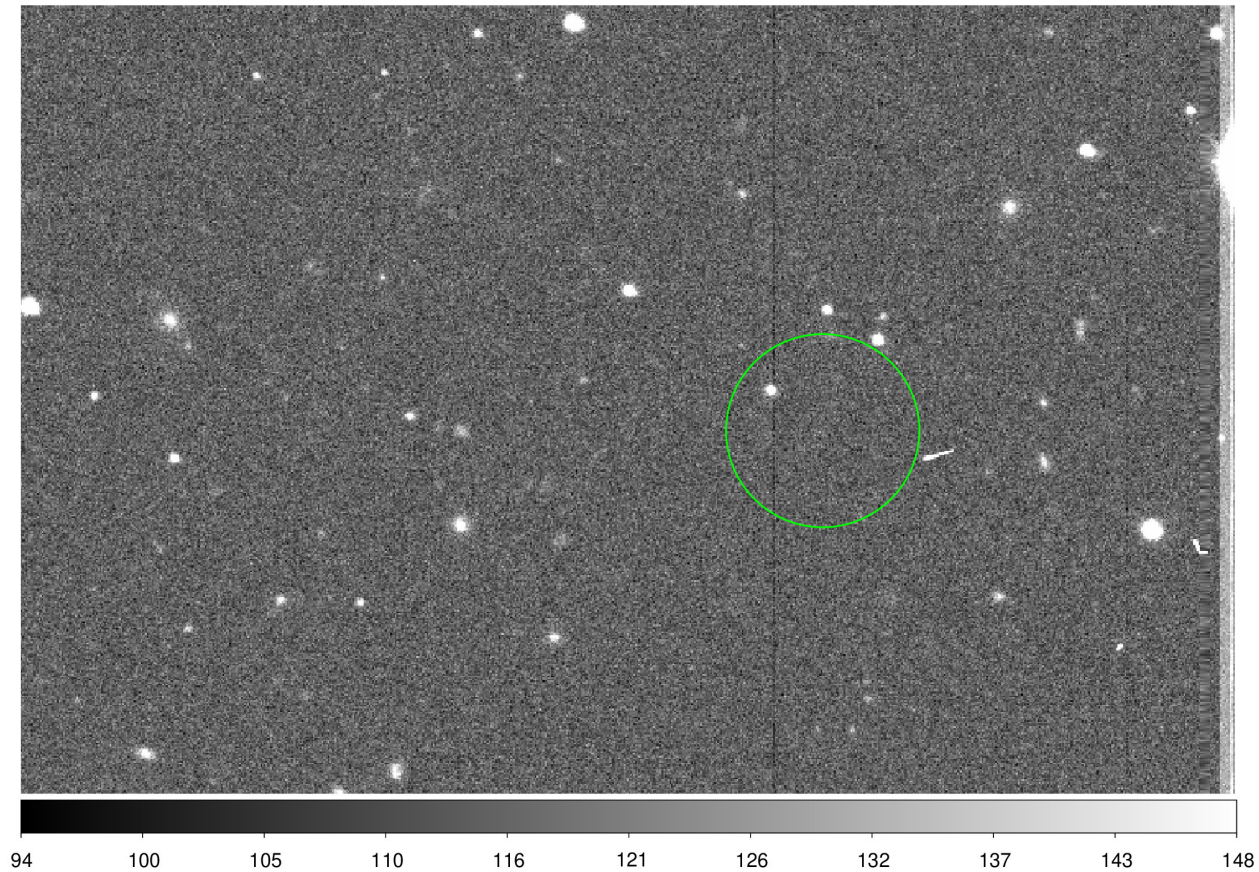
99% of the time a WALLABY source looks like this on the Dark Energy Camera Legacy Survey*



*4m optical telescope with a gigapixel CCD camera in Chile.

1% of the time it looks like this

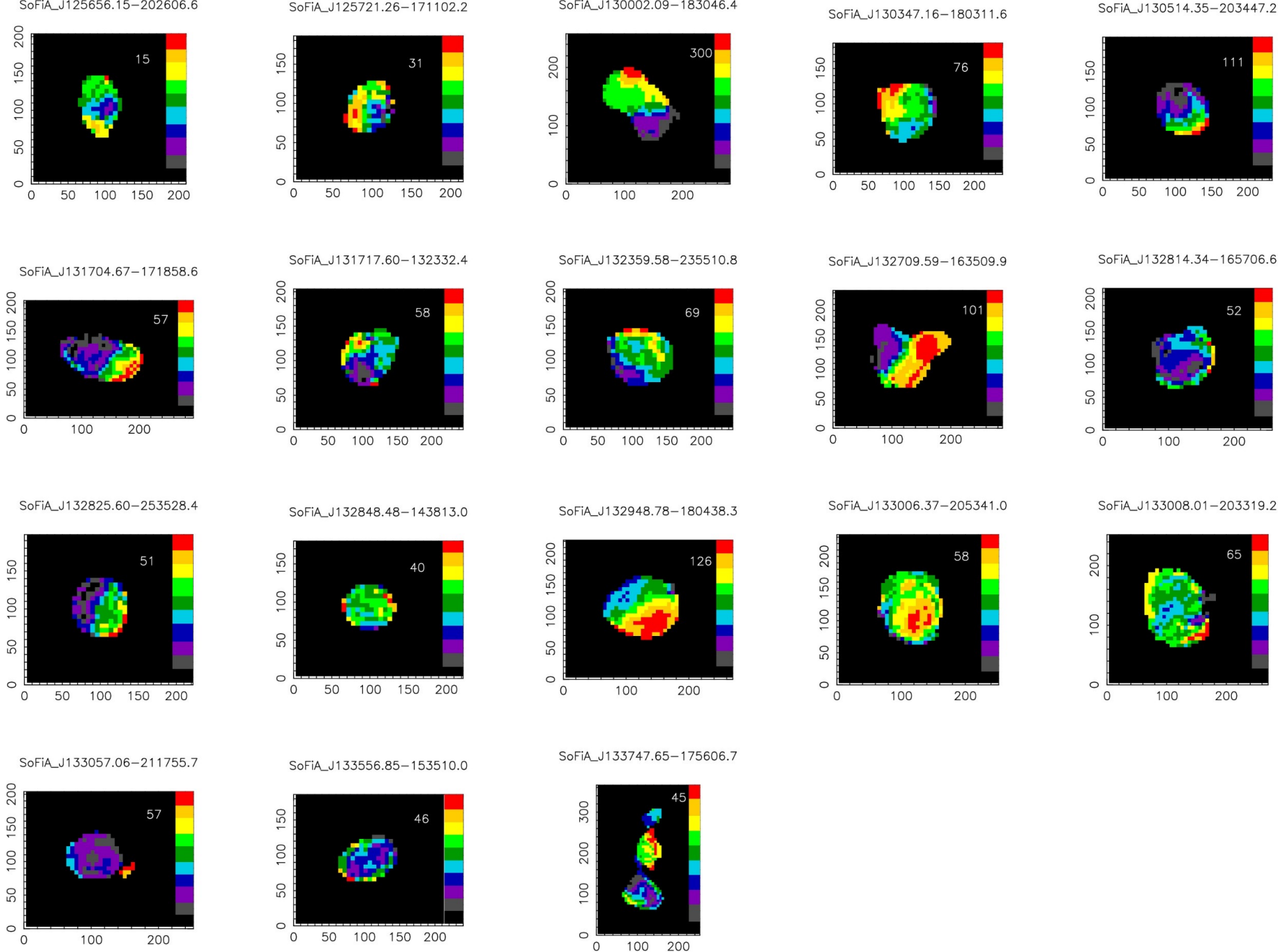
The green circle is the WALLABY beam size. The rms error in position is 10 arcsec, two thirds of the beam radius.



WALLABY J131704-171858

Velocity maps of WALLABY dark galaxies

The white numbers are the velocity range of the colour bars in km/sec



Questions and caveats

- Total masses are from the virial theorem
 - Plausible for rotating galaxies, less so for turbulent velocity fields
- Has anyone seen dark galaxies before ?
 - Arecibo has seen 115 (almost) dark galaxies in the ALFALFA survey
 - FAST is a new Chinese dish 5/3 times the diameter of Arecibo
 - Its first survey is around in preprint form
- Could they be artefacts of radio frequency interference?
 - Probably not, but they should be re-observed
- Are they tidal debris from bigger galaxies?
 - No, there are no bigger galaxies around.
- Are the optical surveys deep enough to call these “dark”?
 - They are as deep as the northern hemisphere’s
 - Fast telescopes, not large telescopes are the most sensitive for nearby, big objects

The Huntsman Telescope (Macquarie University)

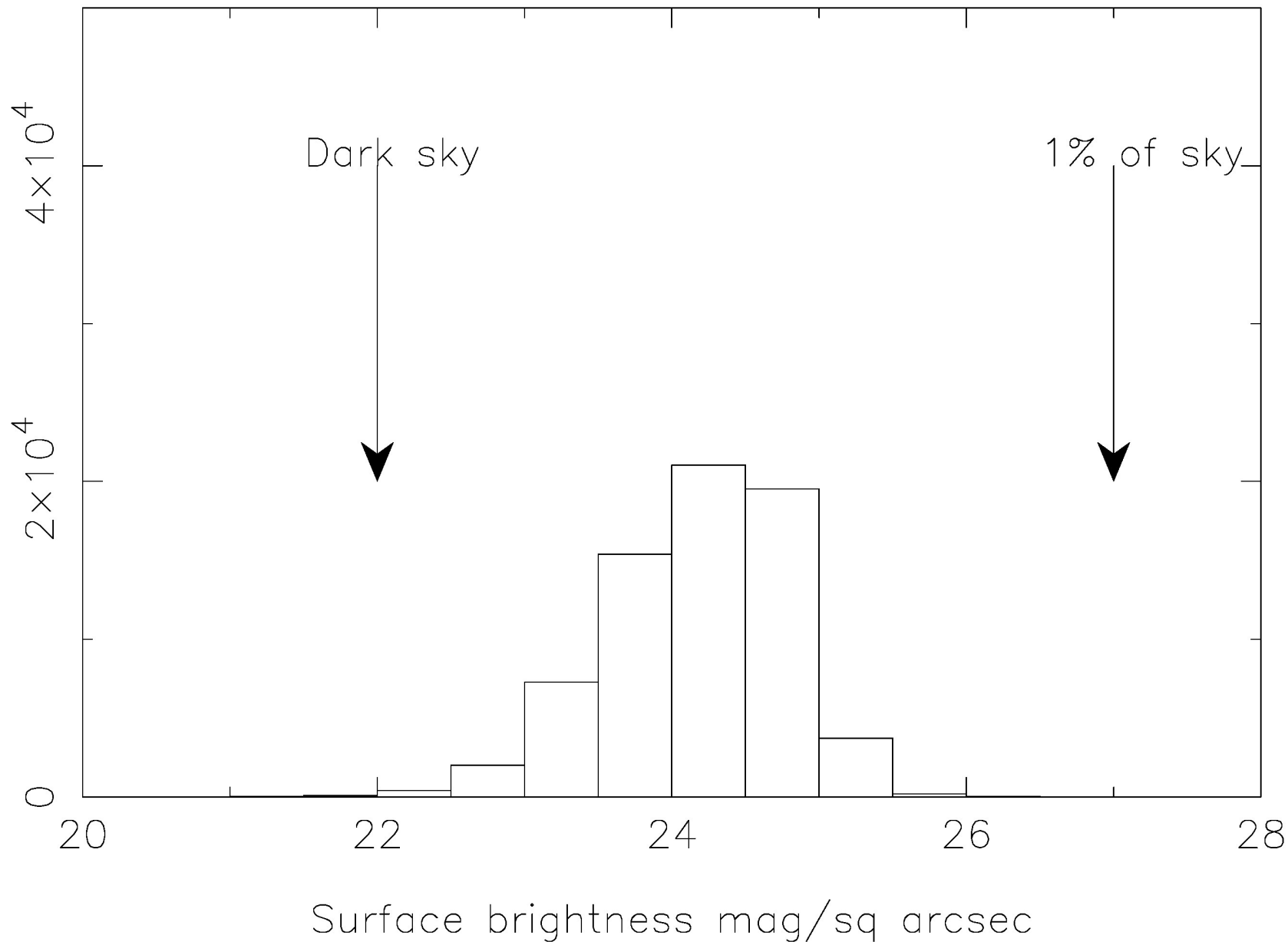
Located at Siding Spring Observatory, Australia's dark site Observatory, which hosts the AAT.



DELVE optical galaxy catalog (radii > 5 arcsec)

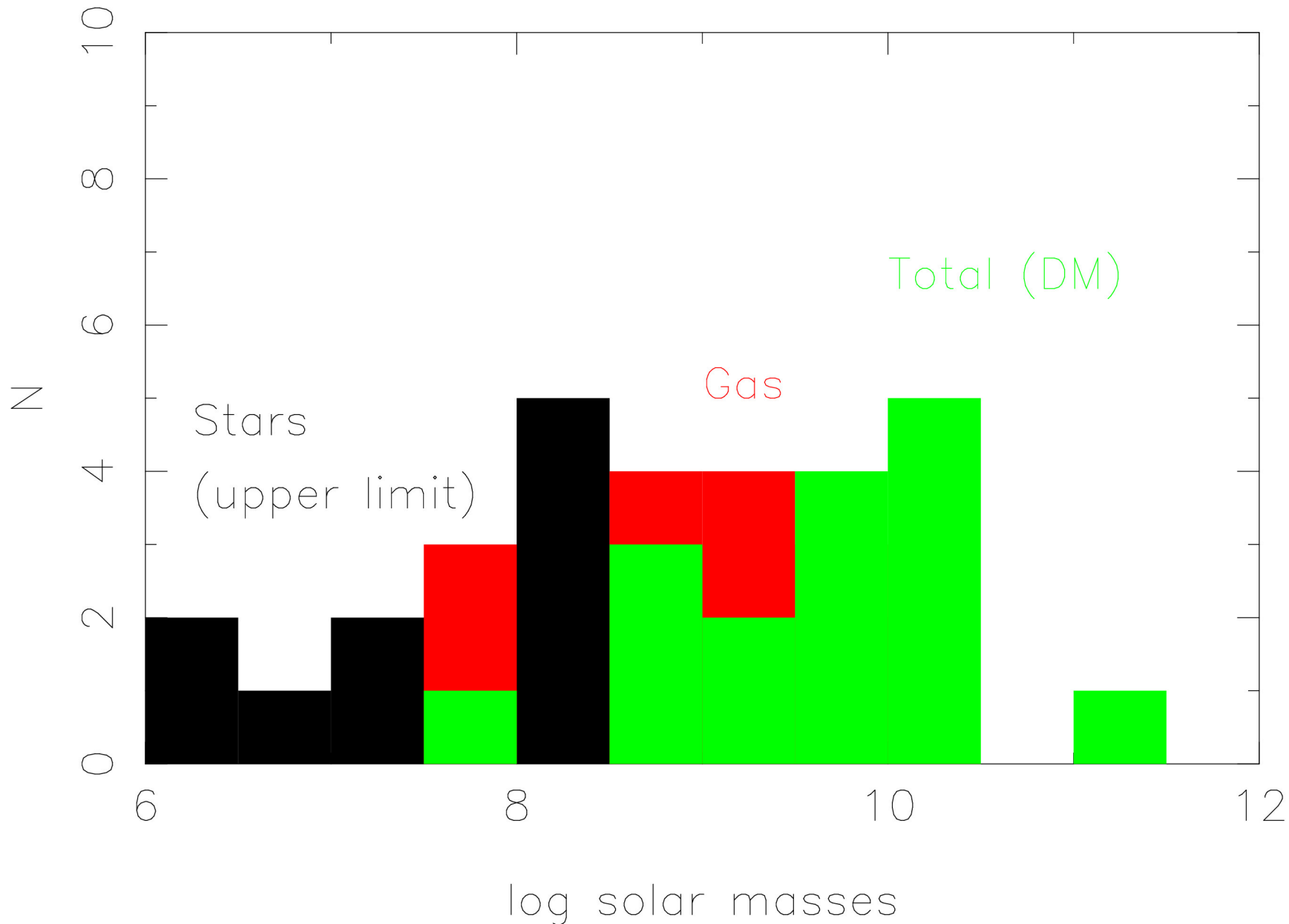
Criterion
for a
WALLABY
dark
galaxy

1% of sky
background



Masses of WALLABY dark galaxies

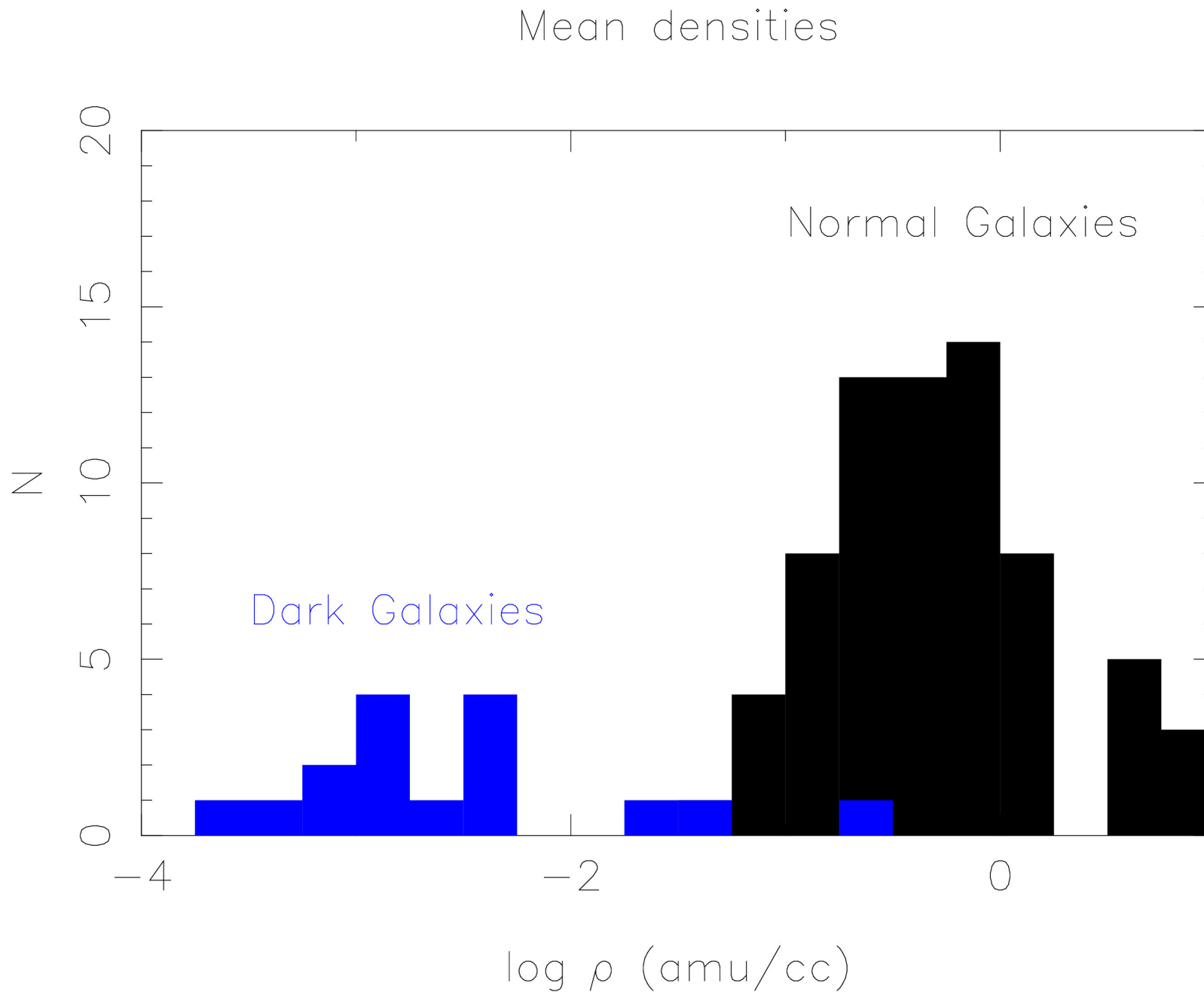
Dark Galaxies



There could be additional gas in molecular and ionized form

Dark galaxies
have a lower
total mass
density
than normal
galaxies

At these densities the free fall
time $1/\sqrt{G\rho}$ is a few tenths
of the age of the Universe



Alejandro Benitez-Llambay & Carlos Frenk 2020

Hydrodynamic models (dark matter + gas + a star formation 'law')

Our fiducial model predicts a cutoff in the galaxy mass function at a present-day halo mass, $M \sim 3 \times 10^8 M_{\odot}$;

..... ;

and a population of starless gaseous haloes of present-day mass in the range $10^6 \lesssim M/M_{\odot} \lesssim 5 \times 10^9$, in which the gas is in thermal equilibrium with the ultraviolet background radiation and in hydrostatic equilibrium in the gravitational potential of the halo.

Final questions

- Are theorists worried about dark galaxies?
 - No, “galaxies with 100:1 gas:stars are not rare in simulations.”
- Are observers interested in dark galaxies?
 - Swinburne has a strong group studying “Ultra Diffuse Galaxies” with the Keck Telescope, i.e. starlight
 - Analysis of Galaxies at the Extremes (AGATE)
- Are these (dark/UDG) phenomena related?
 - Interactions that remove gas do happen (e.g. the bullet cluster)

