Hedgehog: An Isolated Quiescent Dwarf Galaxy at 2.4 Mpc

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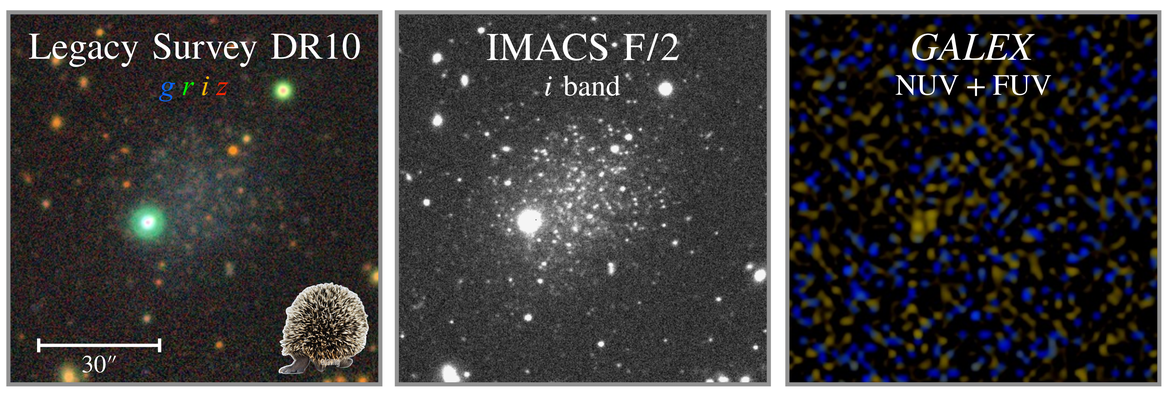
Discovery

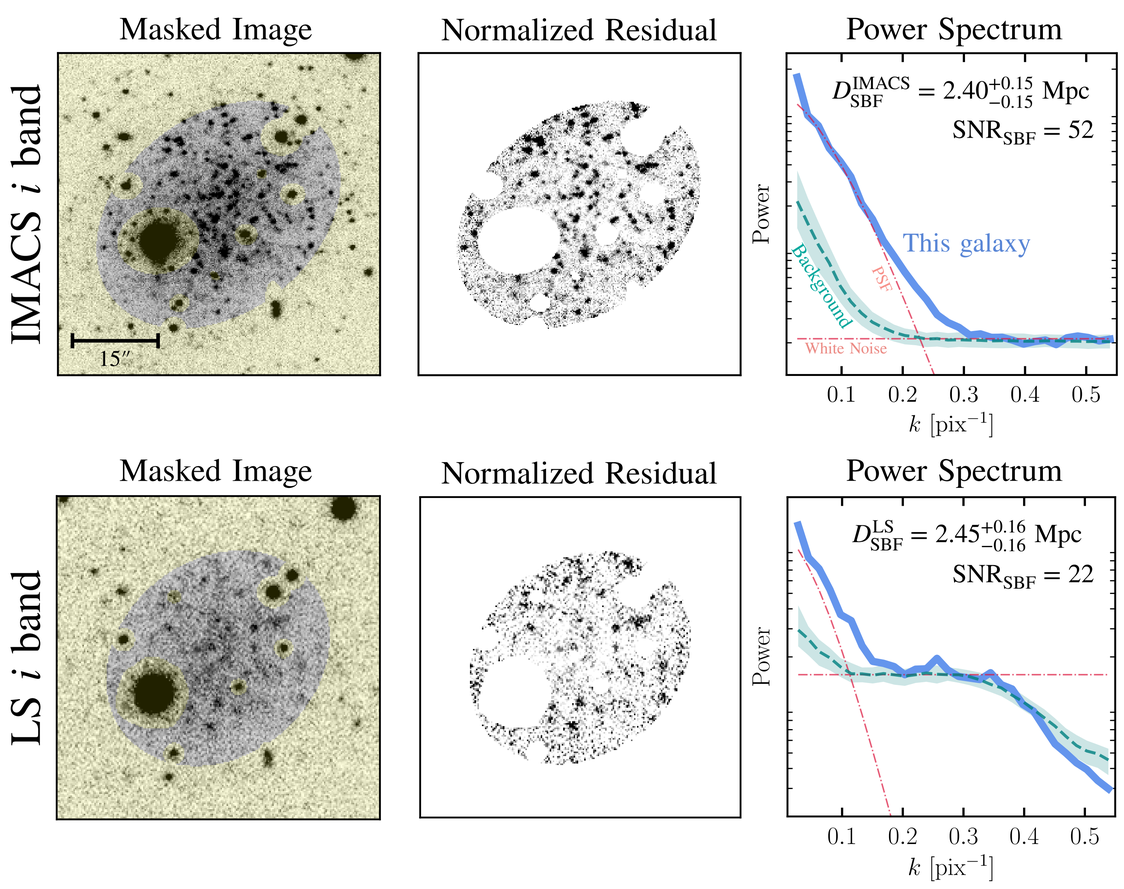
Quiescent dwarfs are extremely rare (<0.06%) among isolated dwarfs with $M_\star = 10^{7-9}\,M_\odot$ (Geha et al. 2012), and only a few such objects have been discovered so far in the local universe. Some are located on the outskirts of the Local Group, while others are found far from any massive galaxy. The mechanisms by which these isolated dwarfs are formed and quenched remain unclear.



We report the discovery of Hedgehog, **another isolated quiescent dwarf galaxy at $D \approx 2.4$ Mpc with $M_\star \approx 10^{5.8}\,M_\odot$.** It was discovered serendipitously in the Legacy Surveys DR10 data and was followed up with the IMACS imager on the 6.5-m Magellan Baade Telescope.

Surface Brightness Fluctuation Distance

Surface brightness fluctuation (SBF) measures the pixel-to-pixel variation due to the Poisson fluctuations in the number of bright stars, so the SBF signal depends on both distance and the stellar population.



We measure the SBF distance to Hedgehog ***independently*** using both IMACS and Legacy Surveys DR10 i-band data using the calibration in Carlsten et al. (2019):

$$D_{\rm SBF}^{\rm IMACS} = 2.40 \pm 0.15\ {\rm Mpc}, \quad {\rm D}_{\rm SBF}^{\rm LS} = 2.45 \pm 0.16\ {\rm Mpc}.$$

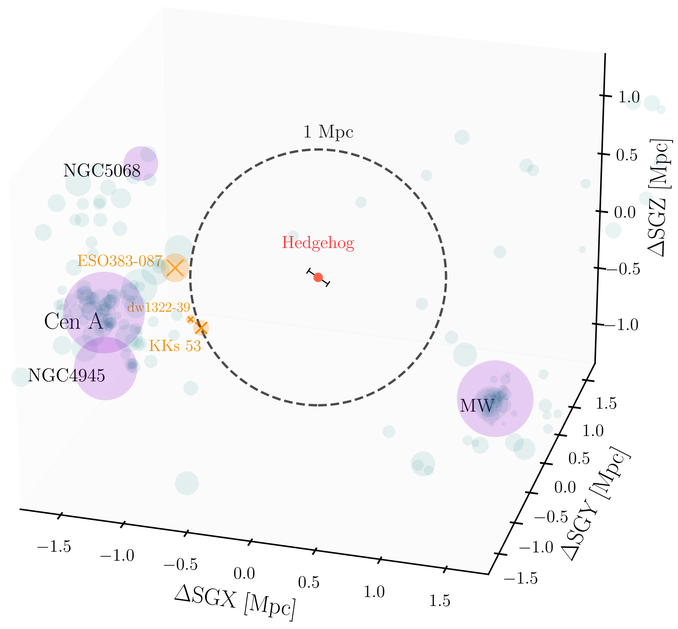
The properties of Hedgehog under this distance are shown below:

α_0 (J2000)	$13:22:46.88$
δ_0 (J2000)	$-20:53:55.94$
m_g (mag)	17.35 ± 0.06
$g-r$ (mag)	0.49 ± 0.05
$g-i$ (mag)	0.62 ± 0.05
$r_{\rm eff}$ (arcsec)	15.1 ± 0.8
$\mu_{0,g}$ (mag arcsec^{-2})	24.80 ± 0.15

Distance (Mpc)	2.40 ± 0.15
M_g (mag)	-9.56 ± 0.14
M_V (mag)	-9.84 ± 0.16
$\log(M_\star/M_\odot)$	5.8 ± 0.2
$r_{\rm eff}$ (pc)	176 ± 14
$\log({\rm SFR_{NUV}}/{\rm M_\odot\,yr^{-1}})$	< -3.7
$\log(M_{\rm HI}/M_\odot)$	< 6.0

Environment

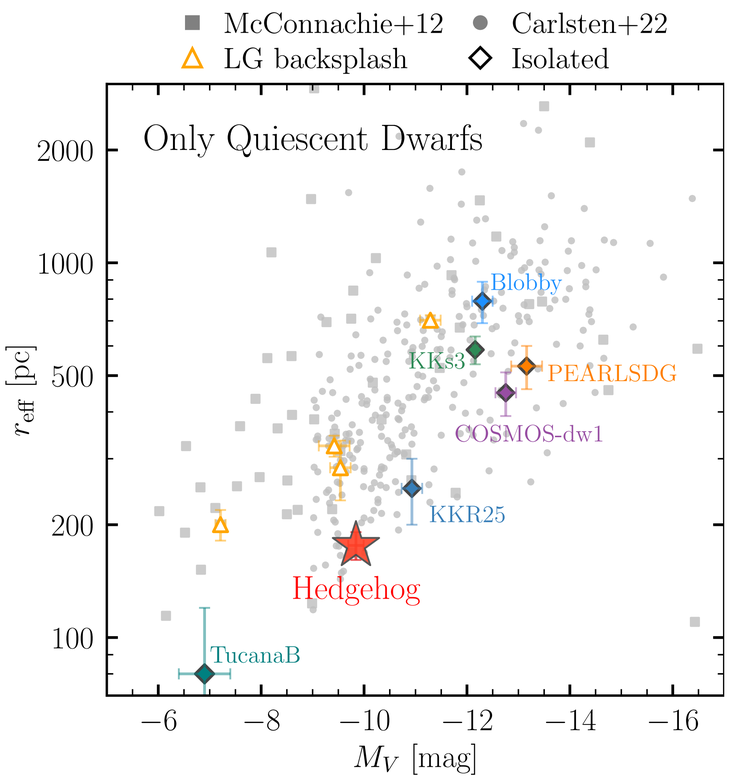
Hedgehog is one of the most isolated quiescent dwarf galaxies in the Local Volume. It is 1.7 Mpc ($4-5\ R_{\rm vir}^{\rm CenA}$) from its closest group Centaurus A, placing it in a very isolated environment. The closest dwarf galaxy to Hedgehog, KKs 53, is 1 Mpc away from it. The other neighbors of Hedgehog are mostly low-mass dwarf galaxies distributed towards the Cen A group.



Properties and Stellar Population

Hedgehog is quiescent – it has an early-type morphology and a red color, and does not show significant UV emission and HI detection. The non-detection in UV gives an upper limit on SFR $< 10^{-3.7}\ M_\odot\,{\rm yr}^{-1}$. The optical color is consistent with a 5–7 Gyr SSP with an average metallicity for its mass.

Hedgehog seems to have **a smaller size** for its luminosity but is consistent with the size–luminosity relation. Intriguingly, some other isolated quiescent dwarfs (highlighted as diamonds) also exhibit **smaller sizes**.



Formation and quenching mechanism

- **Backsplash galaxy from Cen A group**: 4–6 Gyr for Hedgehog to travel to its current location, roughly agree with the age of its stellar population. Cen A might also have had a recent merger.
- **Quenched by the cosmic web or stellar feedback**
- **Reionization fossil**: Hedgehog's mass is marginally in the reionization-quenching regime. Its small size might indicate a slightly lower halo mass and thus is easier to be quenched.

Future directions (happy to collaborate!)

- Deep CMD to unveil its star formation history (*HST*, *JWST*)
- Radial velocity and velocity dispersion measurement; HI observation.
- Could any model reproduce the small sizes of isolated quenched dwarfs?
- What is the quenched fraction of field dwarfs at $M_\star \approx 10^6\ M_\odot$? A blind SBF survey is the way to go!