

Revealing the Origins of Ultra-Compact Dwarf Galaxies with Panoramic Deep Imaging

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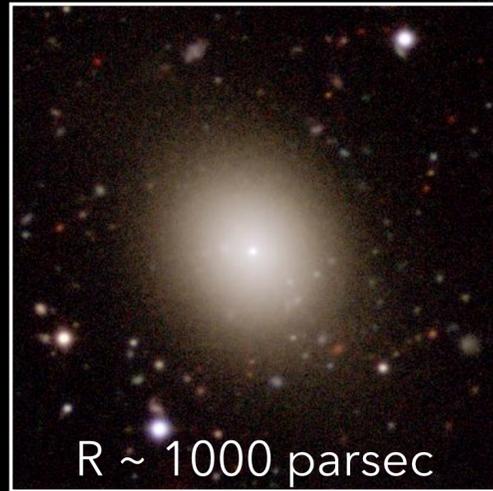
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What are ultra-compact dwarf galaxies (UCDs)?

Virgo is the nearest massive galaxy cluster

dwarf galaxy



M86

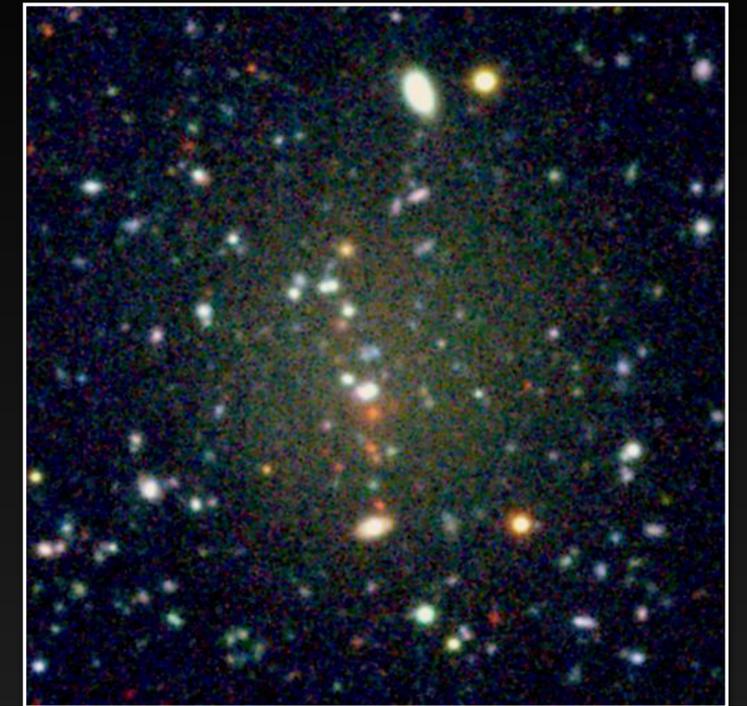
M84

M87

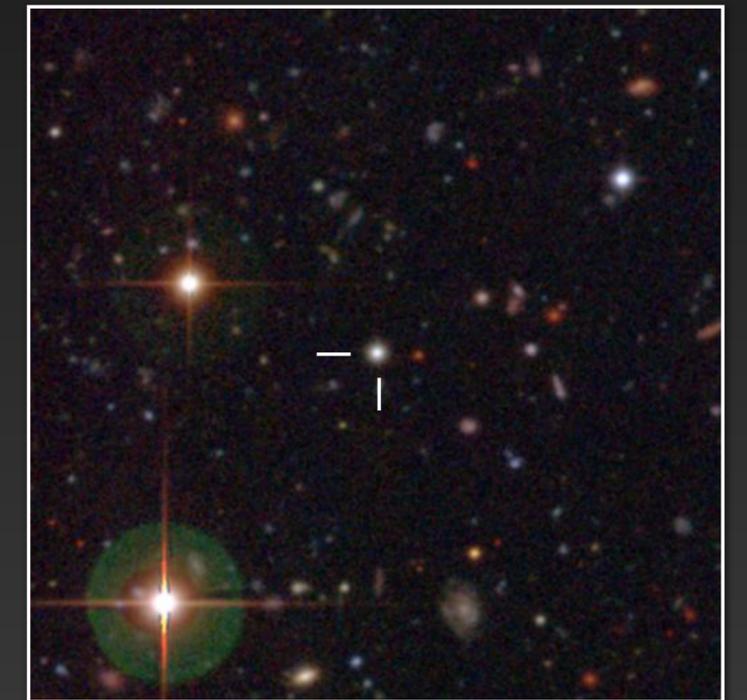
UCD

R ~ 10 - 100 parsec
 $10^6 - 10^8$ Solar Mass

ultra-diffuse galaxy (UDG)

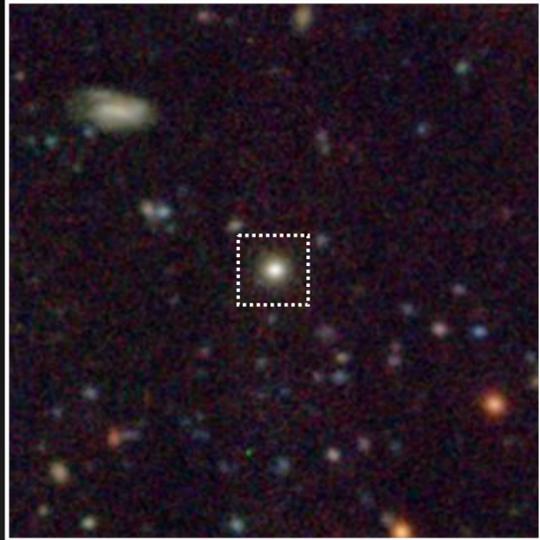
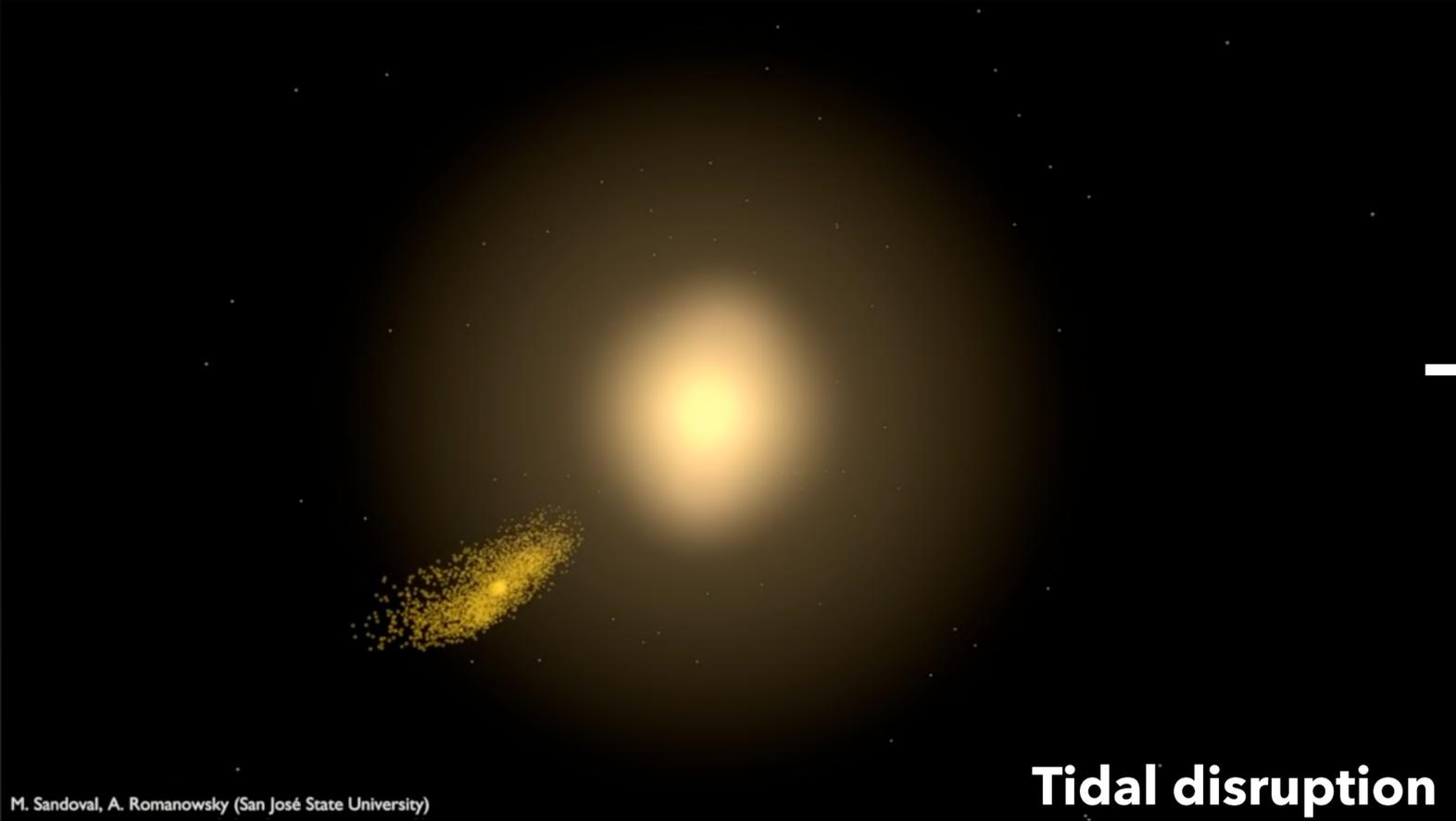


Same scale



ultra-compact dwarf galaxy

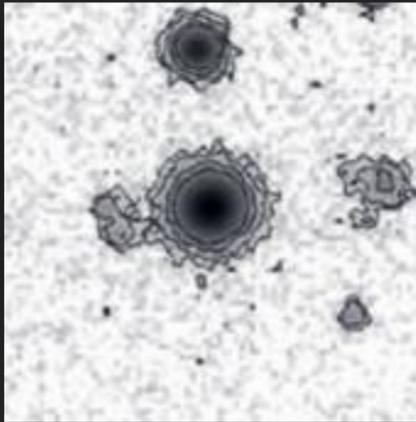
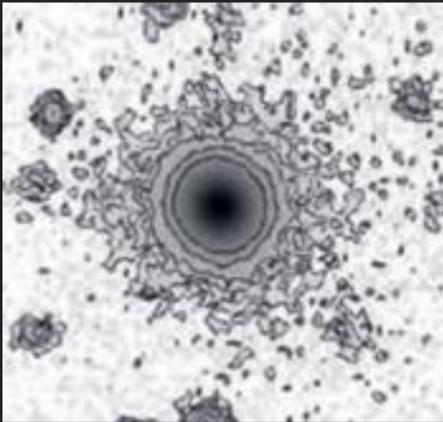
The most massive star clusters or stripped nucleated dwarf galaxies?



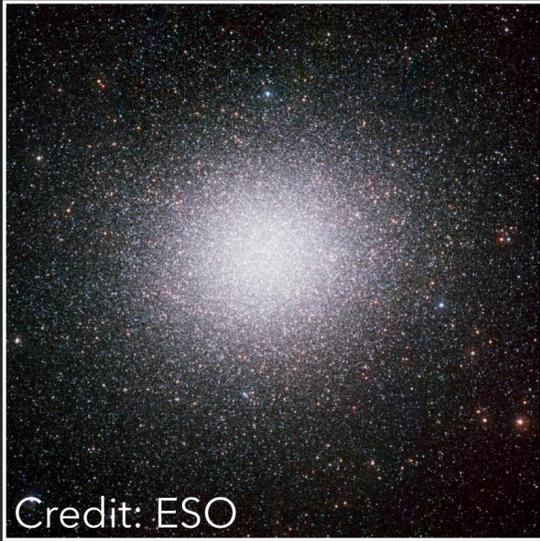
Nucleated dwarf galaxy
(Galaxy that contains
a central **nuclear star cluster**)

Tidal disruption

Where are those nucleated dwarf galaxies that are undergoing tidal disruption?



UCD with/without diffuse envelopes



Massive Globular Cluster

Searching for **UCD progenitors**

~55 strongly nucleated dwarf galaxies

*The Next Generation
Virgo Cluster Survey (NGVS)*

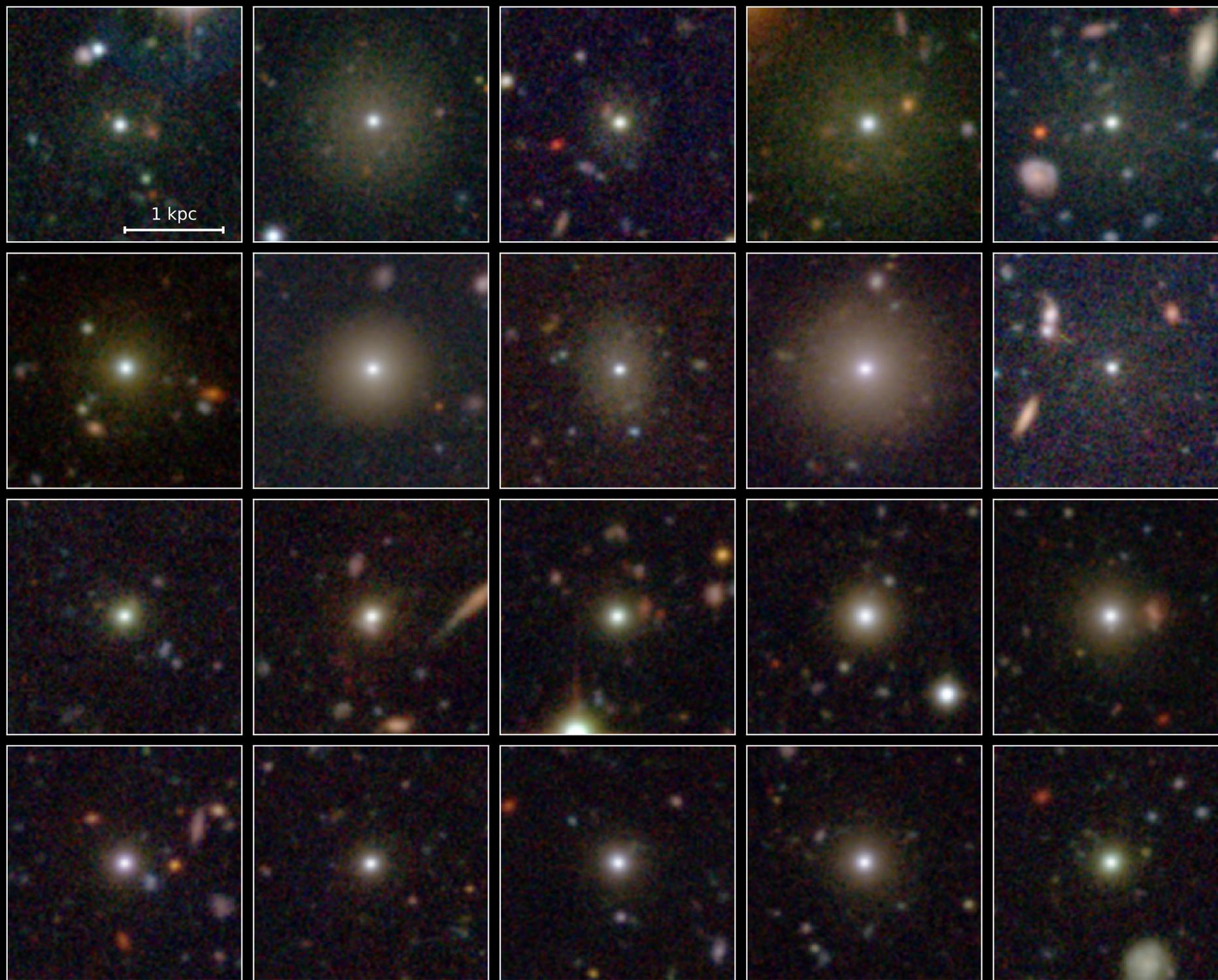


**High resolution,
deep imaging
across the whole
Virgo Cluster**

Canada-France-Hawaii Telescope
(CFHT)

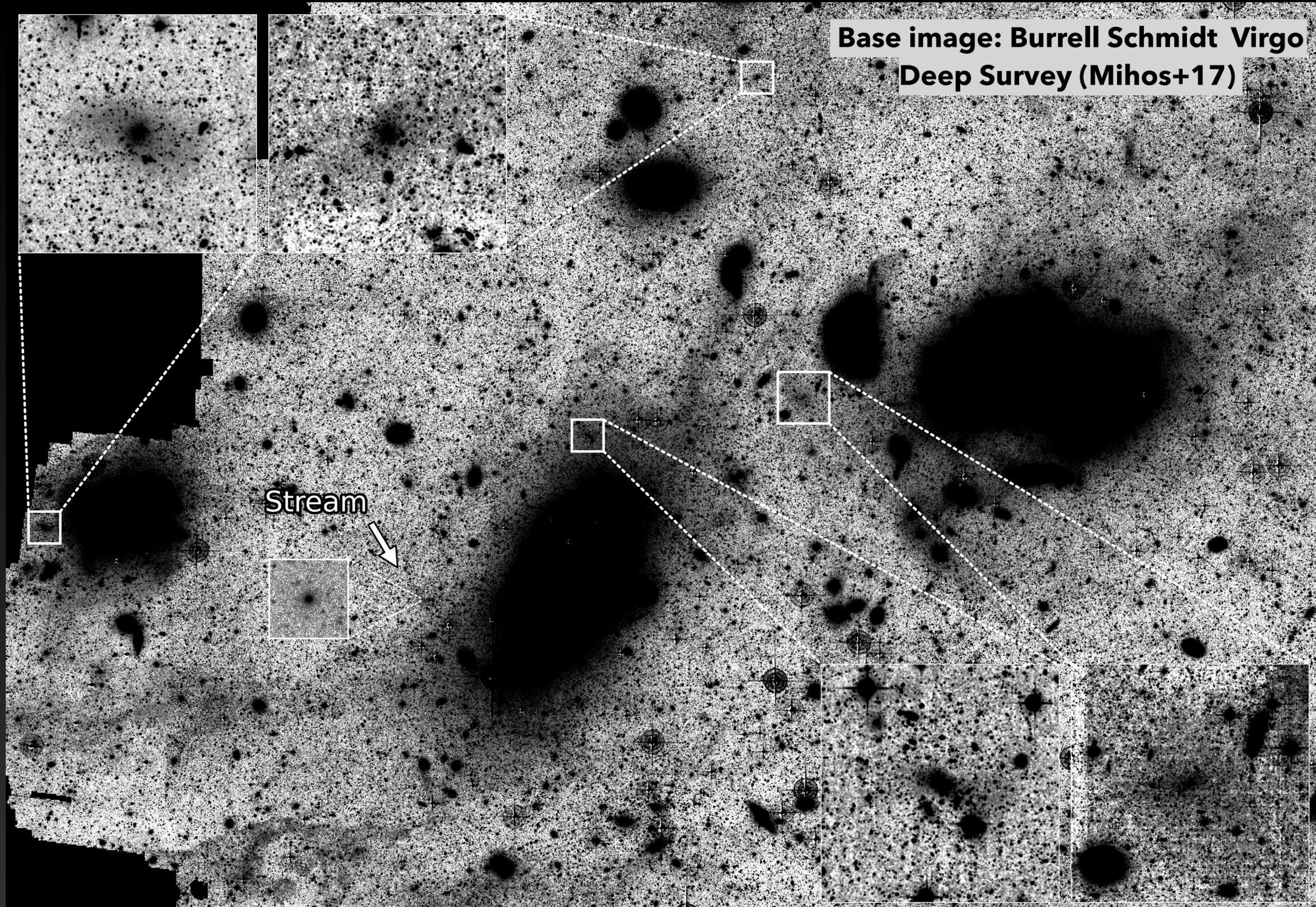
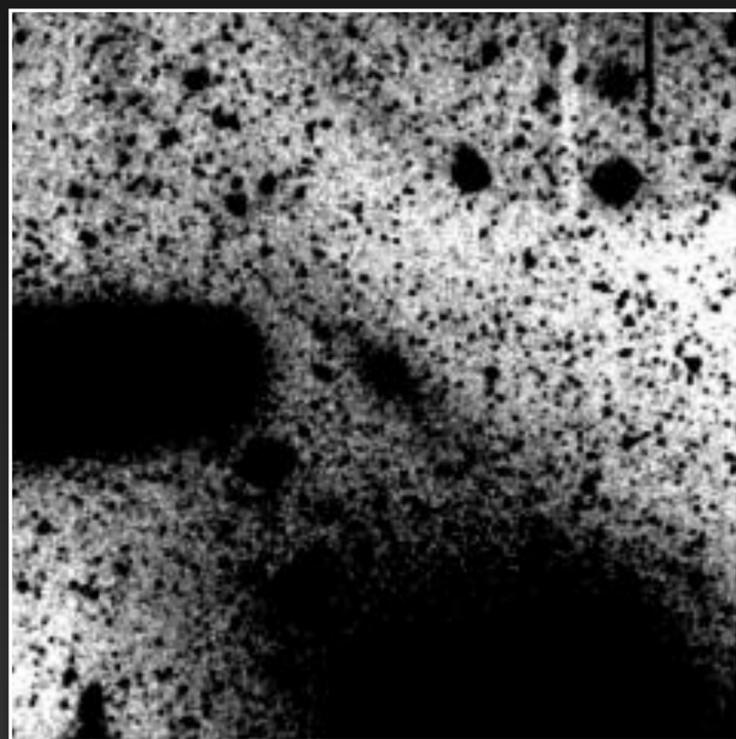


Credit: CFHT



~70 UCDs with diffuse envelopes (spectroscopically confirmed)

Faint tidal features around dEs and UCDs

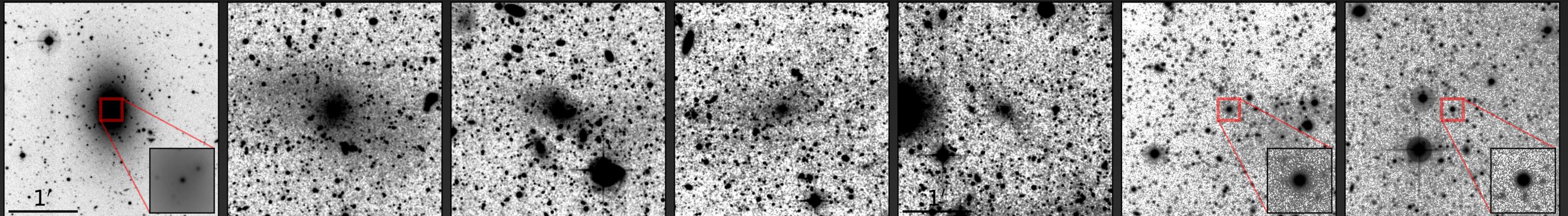


Push the surface brightness limit
to ~ 29 mag/arcsec²

A few strongly nucleated dwarf galaxies and UCD or GC with envelopes
show clear S-shaped **tidal features** that are **undergoing tidal disruption**

Implications

1. **S-shaped tidal features** around some strongly nucleated dwarf galaxies and ultra-compact dwarf galaxies with envelopes provide “smoking-gun” evidence that **some UCDs originate from disrupted nucleated dwarf galaxies**.
2. Some **ultra-diffuse galaxies (UDGs)**, as the **transient stage** during tidal stripping, share the **common origin** with ultra-compact dwarf galaxies. This mechanism could produce **dark matter deficient UDGs** (e.g. NGC 1052-DF2, DF4).

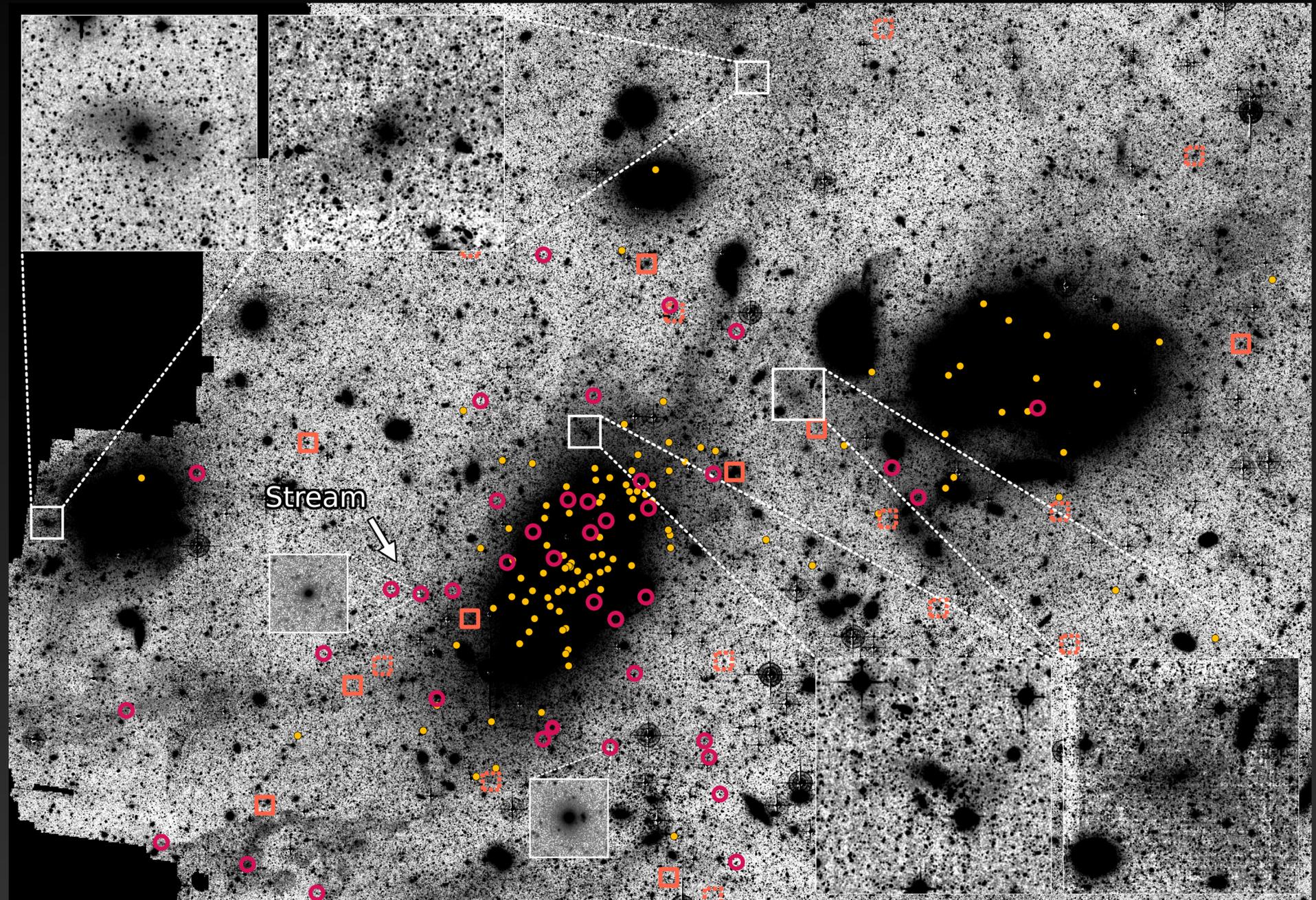


Morphological transformation from undisturbed nucleated dwarf galaxies to UCDs
“Time Machine”

Implications

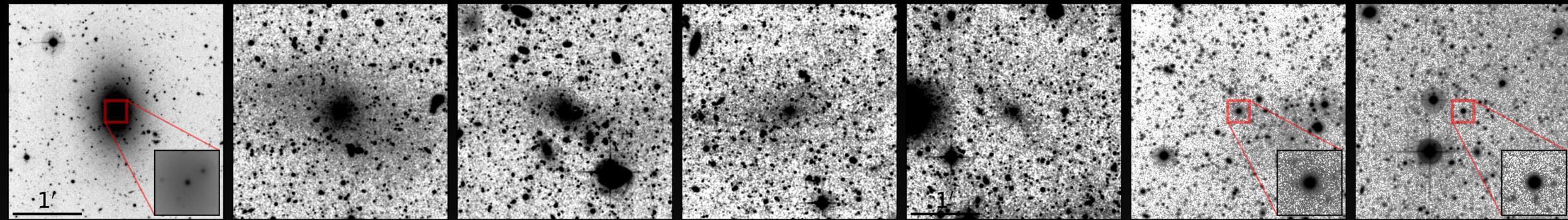
3. The formation of UCDs reflect the **violent history** and **still ongoing mass assembly** in Virgo. There could be a **recent group infall** of galaxies to the cluster center **in the past 2-3 billion years**.

4. UCDs represent a substantial population of **"missing" dwarf galaxies** and black holes in the Local Universe that have been overlooked for a long time.



UCDs
UCD with envelopes
Strongly nucleated dEs

Summary



- Ultra-compact dwarf galaxies (UCDs) are compact stellar systems that blur the classical division between dwarf galaxies and star clusters.
- Our systematic search finds ~ 70 UCDs with diffuse envelopes and ~ 55 strongly nucleated dEs in Virgo. They form a continuum of morphology from normal nucleated dEs to UCDs.
- By identifying tidal features around eight objects, we are “witnessing” the formation of UCDs by tidal disruption of nucleated dwarf galaxies, for the first time. The process contains a transient “ultra-diffuse” stage.
- UCDs provide a unique opportunity to understand the dwarf galaxy evolution and mass assembly history of massive galaxies in clusters.

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For more details, come to my talk at
10:30 - 10:50 AM, Jan. 12th, Room 613
Program Number: **426.04**
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