

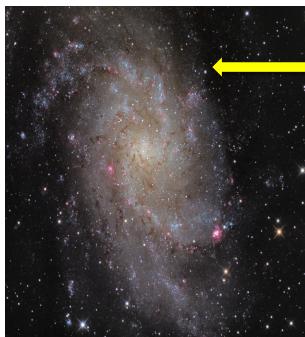
What is a Dwarf Galaxy?

MASS: $\sim 10^5 < M_* < 5 \times 10^9 M_\odot$; $Mv > -19$

ROTATION CURVE: $V_{\text{rot}} < 100 \text{ km/s}$

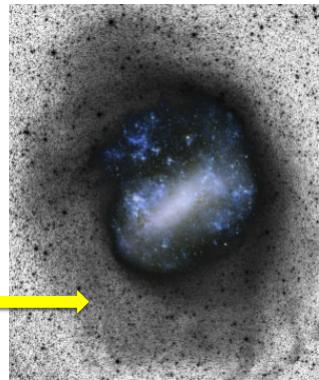
METALLICITY : [Fe/H] < -0.4 ~ 1/3 Z_⊙

Evidence for a dark matter halo



- M33 is a satellite, but not a dwarf.

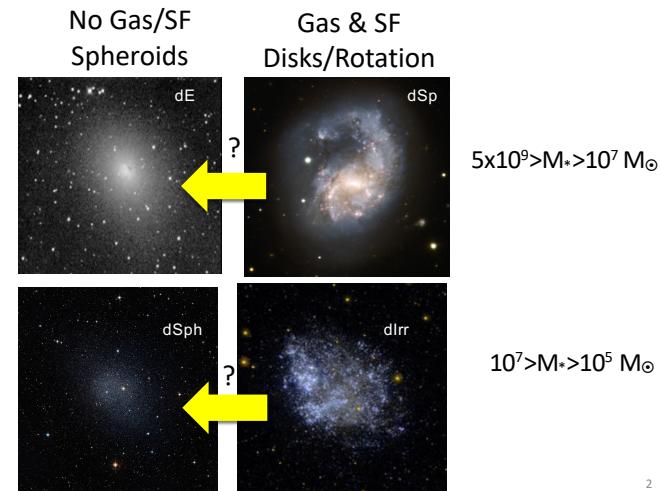
The LMC is.



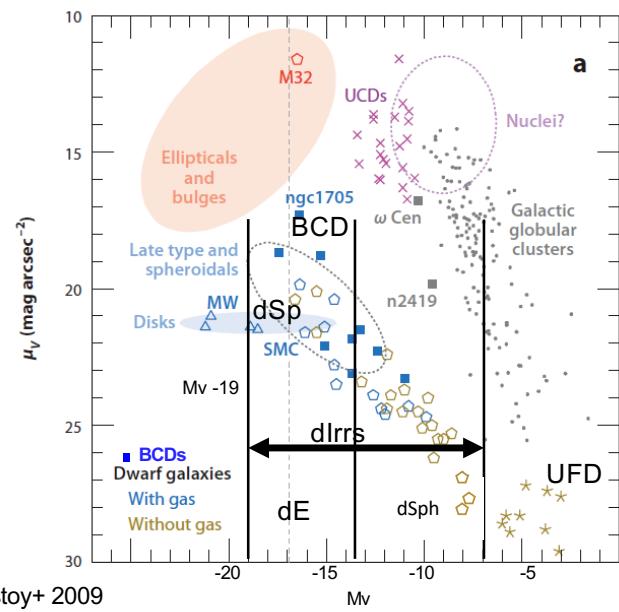
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The Dwarf Galaxy Zoo: Main Flavors at all mass scales

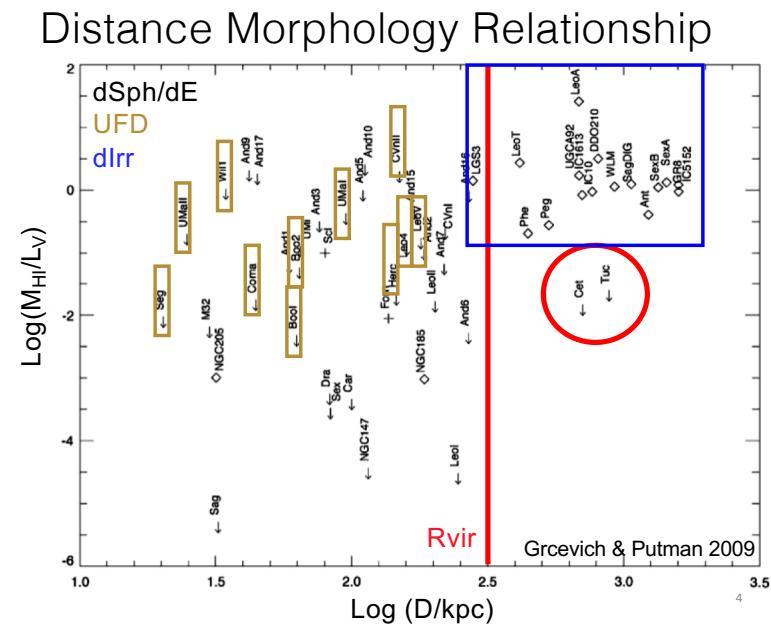


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Tolstoy+ 2009

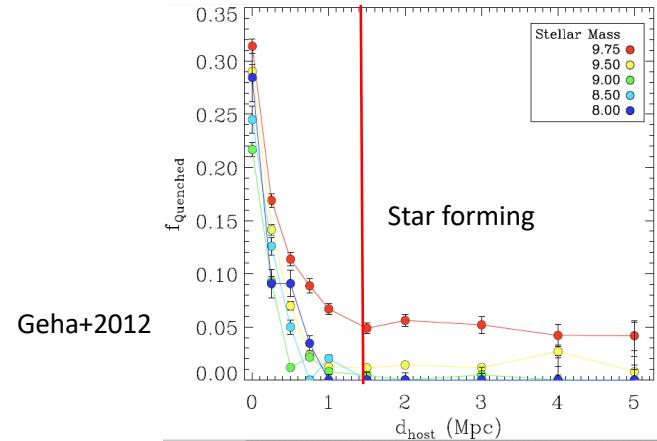
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Dwarf galaxies are gas rich & forming stars
UNLESS they are close to a massive galaxy

Dwarfs (10^8 - $10^9 M_{\odot}$) DON'T quench via secular processes



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Quenched

No strong Halpha emission (EW < 2 Angstrom)
And a strong 4000 Angstrom-break

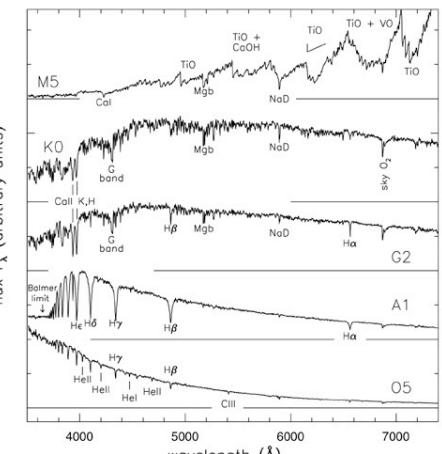
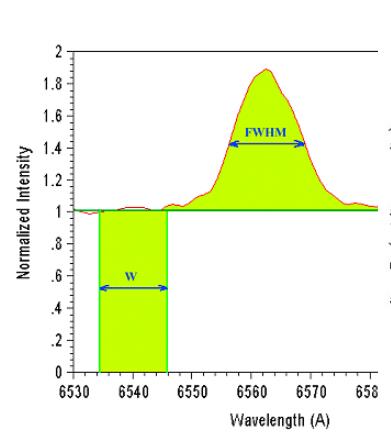
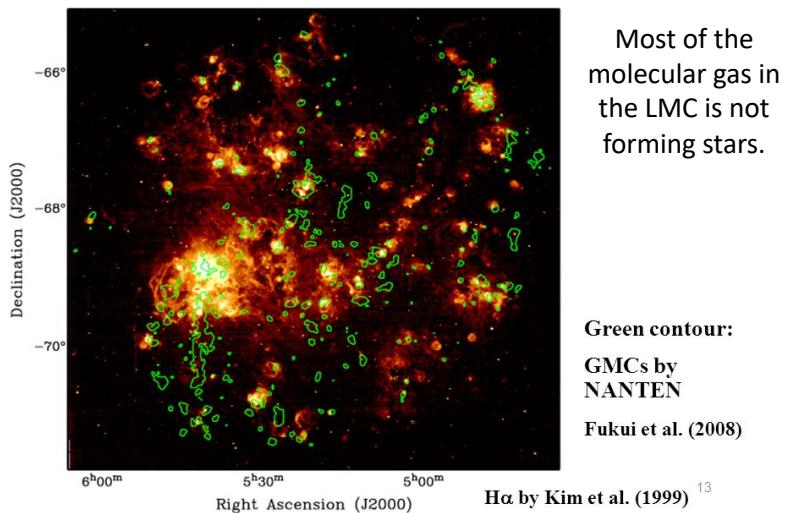


Fig 1.1 'Galaxies in the Universe' Sparke/Gallagher CUP 2007

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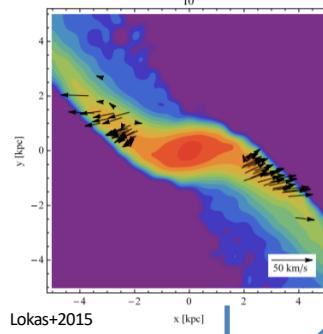
Star formation is inefficient at low metallicity
LMC: CO and H α



Most of the molecular gas in the LMC is not forming stars.

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TIDAL STRIPPING

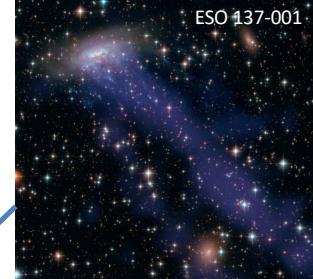


STRANGULATION/STARVATION
“out of fuel”
(gas supply cut off, stars form passively)



animations: Aeree Chung

RAM PRESSURE STRIPPING

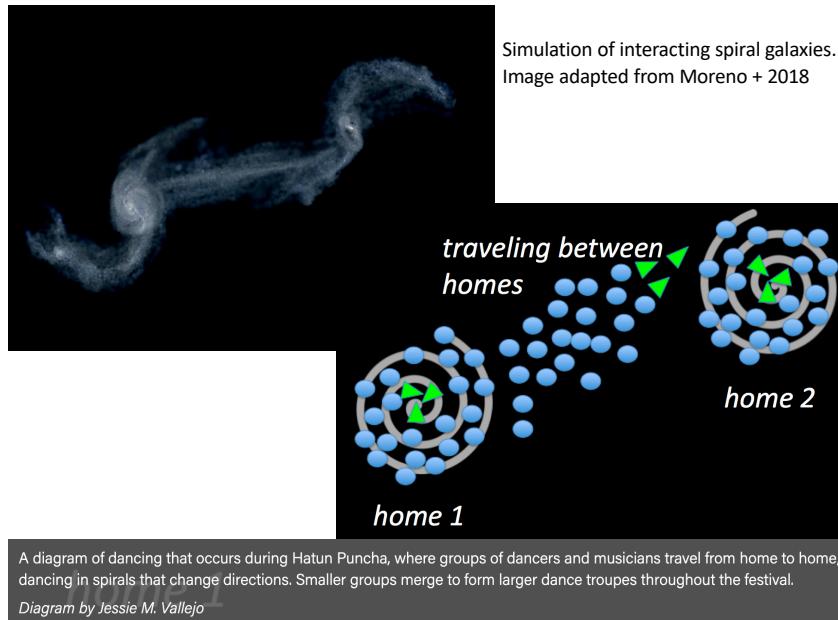


HARRASSMENT



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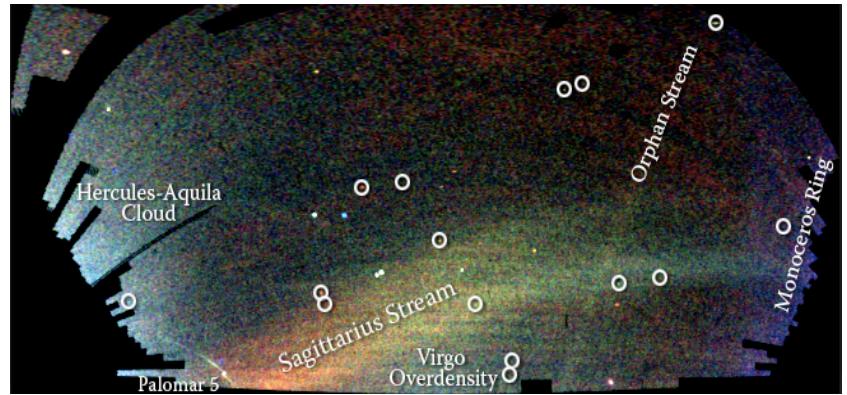
Jorge Moreno's Suggested Change of Language

<i>hierarchical scenario</i>	<i>ancestral scenario</i>
<i>devouring</i>	<i>including</i>
<i>cannibalism</i>	<i>collectivism</i>
<i>harassment</i>	<i>communion</i>
<i>stripping</i>	<i>sharing</i>
<i>strangulation</i>	<i>collaboration</i>
<i>starvation</i>	<i>preservation</i>
<i>disruption</i>	<i>incorporation</i>

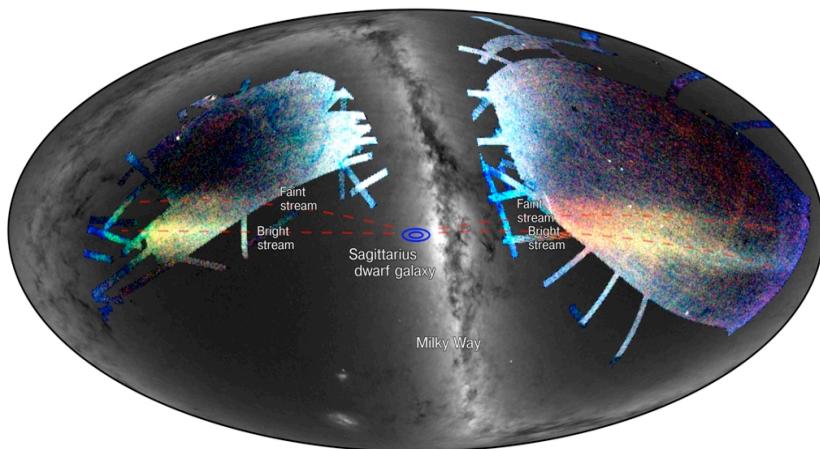
<https://folklife.si.edu/magazine/intergalactic-pachamama-kichwa-cosmology-vs-western-astrophysics>

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SDSS: Field Of Streams

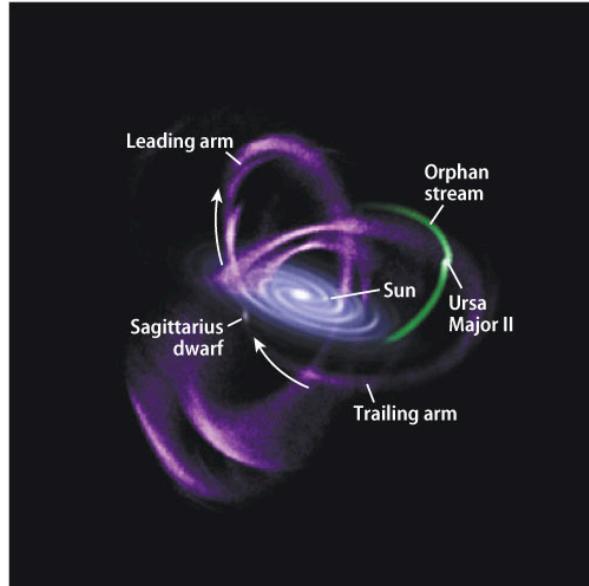


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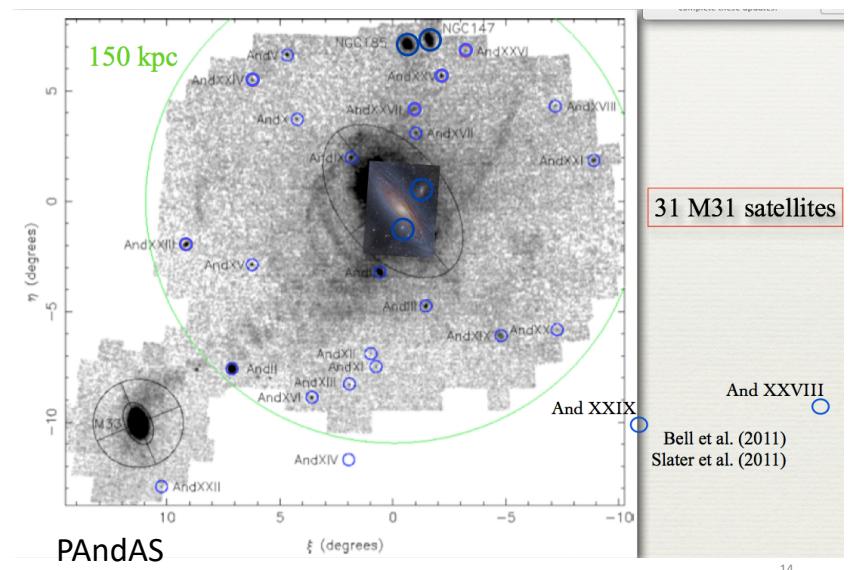


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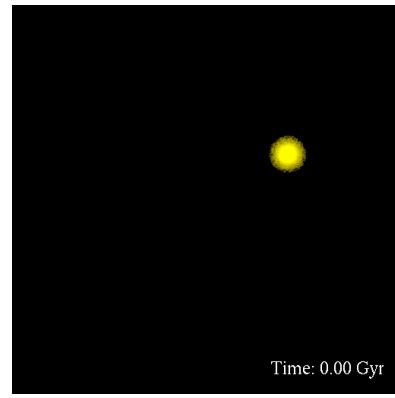
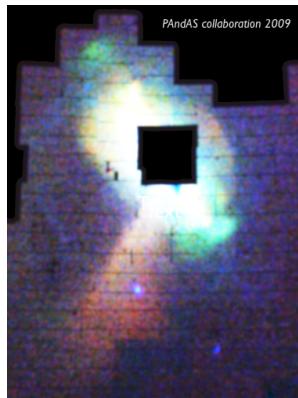


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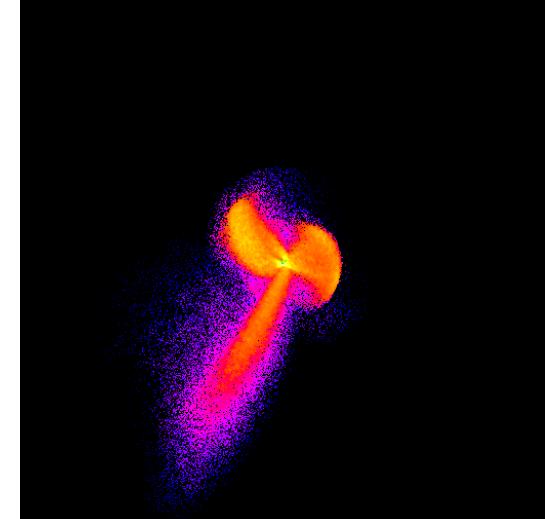
M31 Giant southern stream



Fardal+2009

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Giant Southern Stream



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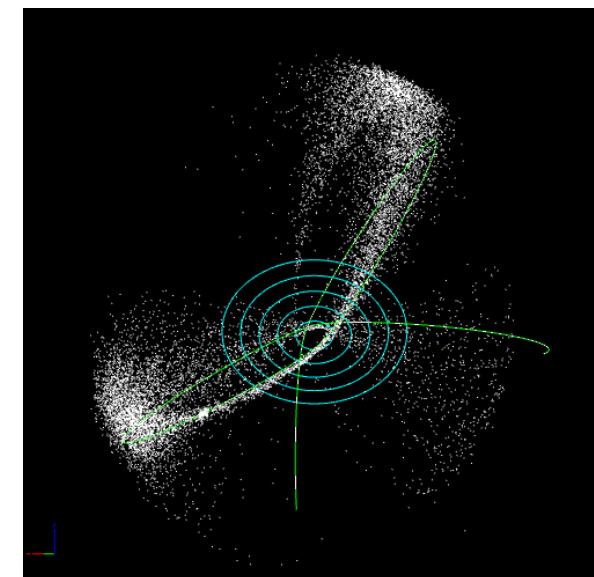
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Stream produced from a satellite on a radial orbit
NGC 4651 (Umbrella Galaxy)



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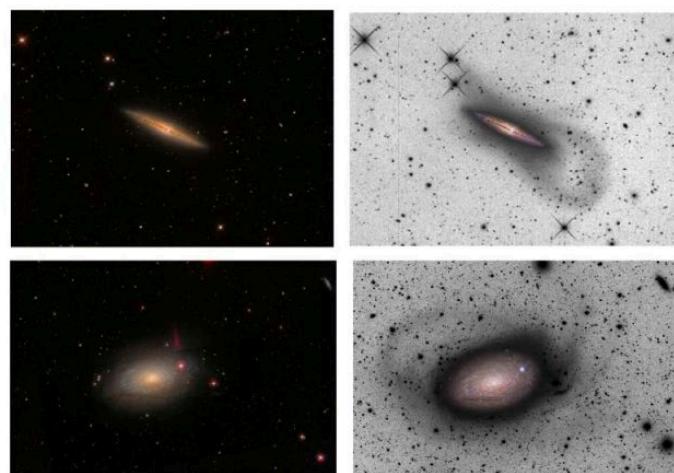
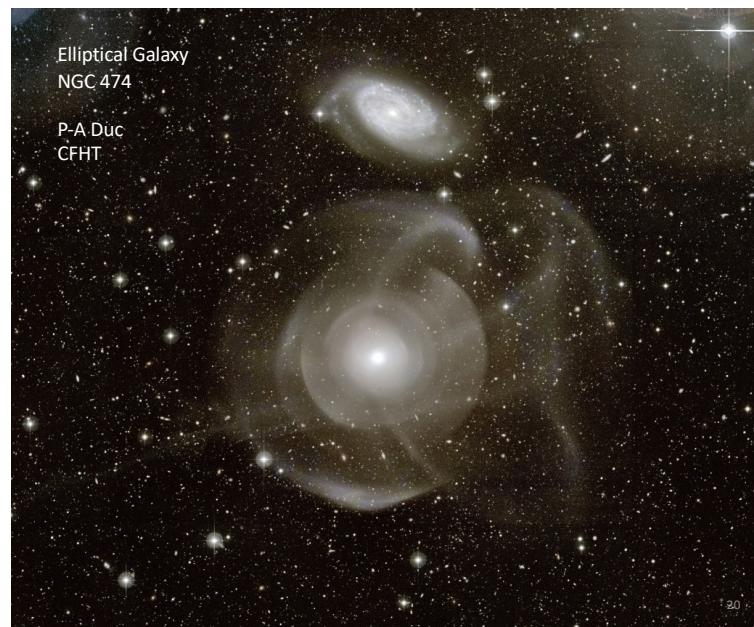


Figure 1. Left panels: images from the Sloan Digital Sky Survey of the nearby galaxies [NGC 4013](#) (top) and [M63](#) (bottom). These images do not show any obvious signs of tidal streams in the halos of these galaxies at the surface brightness limit of SDSS. Deep images of these same galaxies reveal a low-latitude stellar stream around [NGC 4013](#) (upper right panel; [Martínez-Delgado et al. 2009](#)) and a giant tidal stream around the spiral galaxy [M63](#) (lower-right; [Chonis et al. \(2011\)](#)). For reference, a color inset of each galaxy's central regions has been inserted atop the deeper images. These images illustrate the value of deep, sensitive imaging (i.e., beyond that of SDSS) for detecting the faint debris structures predicted by theoretical models in external galaxies.

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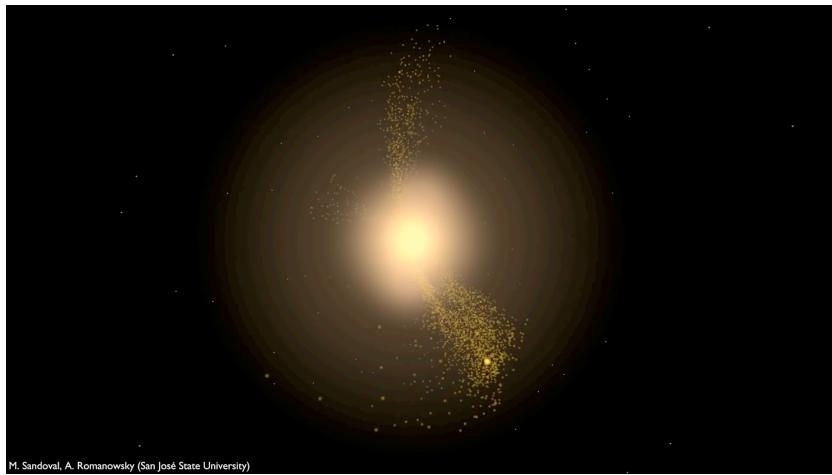


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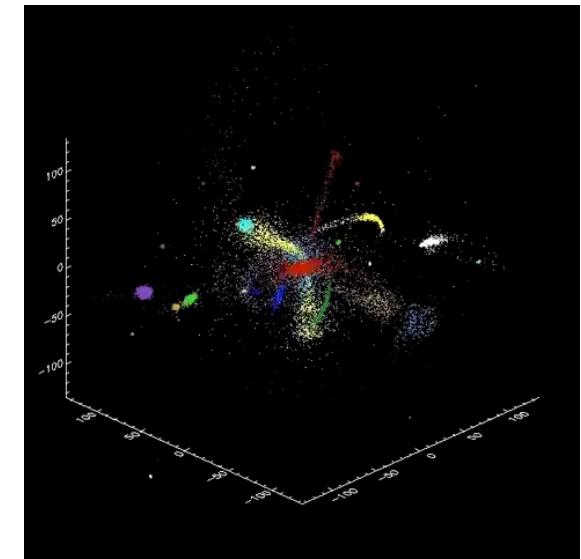
Formation of a UCD: Discovered by undergrads at San Jose State



Sandoval + 2015

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Bullock & Johnston 2005

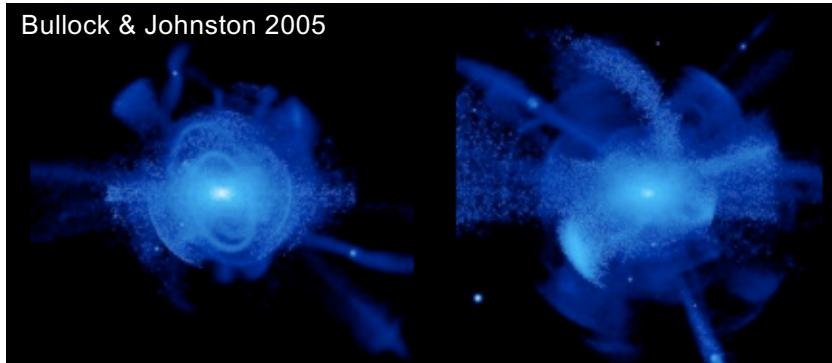
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Tidal Radius: Point mass host, no rotation:

$$r_t \sim (m/4M)^{1/3} D.$$

Bullock & Johnston 2005



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Accounting for centrifugal force:

$$\mathbf{v}' \equiv \frac{d\mathbf{x}'}{dt'} = \mathbf{v} - \Omega \times \mathbf{x}.$$

Jacobi Constant:

$$E_J = \frac{1}{2}\mathbf{v}'^2 + \Phi_{\text{eff}}(\mathbf{x}'), \quad \text{where } \Phi_{\text{eff}}(\mathbf{x}') \equiv \Phi(\mathbf{x}') - \frac{1}{2}(\vec{\Omega} \times \mathbf{x}')^2$$

For a satellite (m) orbiting a host (M):

$$\Phi_{\text{eff}}(x) = -\frac{GM}{|D-x|} - \frac{Gm}{|x|} - \frac{\Omega^2}{2} \left(x - \frac{DM}{M+m} \right)^2.$$

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$$\frac{\partial \Phi_{\text{eff}}}{\partial x} = 0 = -\frac{GM}{(D-x)^2} \pm \frac{Gm}{x^2} - \Omega^2 \left(x - \frac{DM}{M+m} \right)$$

Solutions: Lagrange points L1 and L2 are

$$x = \pm r_J, \quad \text{where } r_J = D \left(\frac{m}{3M+m} \right)^{1/3}$$

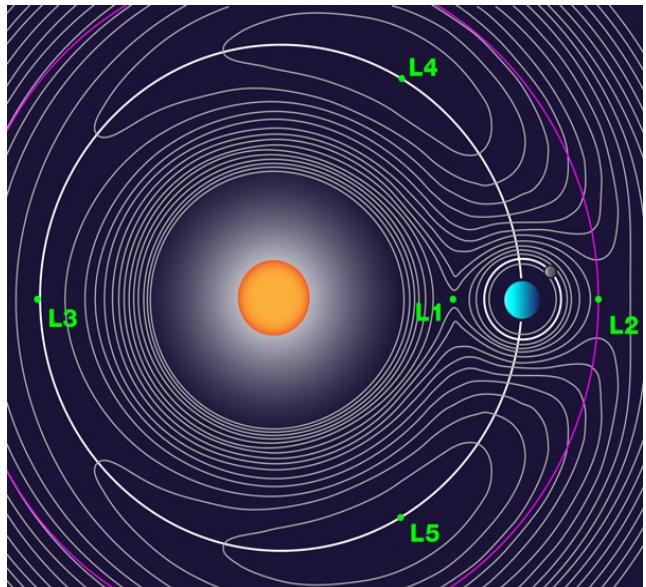
For an extended host (Isothermal Sphere):

$$r_J = D \left[\frac{m}{2M(< D)} \right]^{1/3}$$

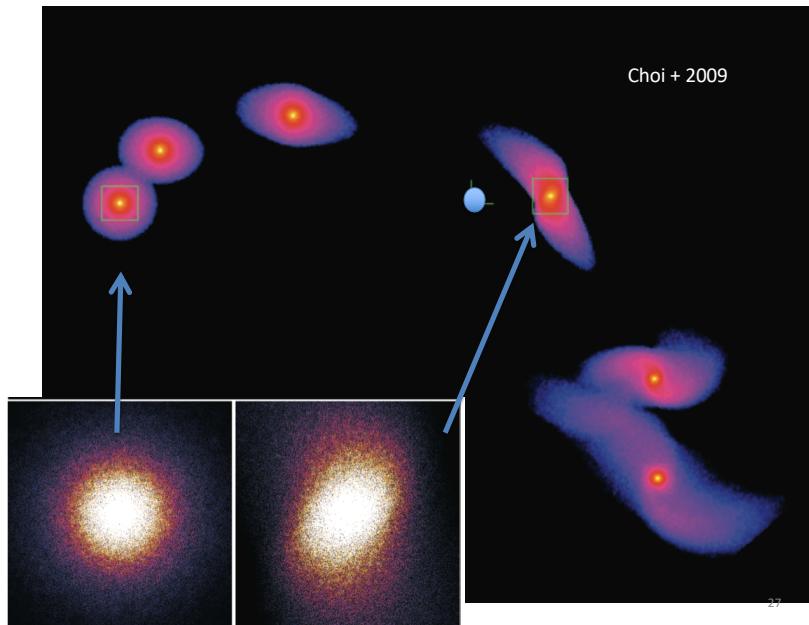
For an extended host (in general):

$$r_J = \left(\frac{GM_{\text{sat}}}{\Omega^2 - d^2\Phi/d^2r} \right)^{1/3}$$

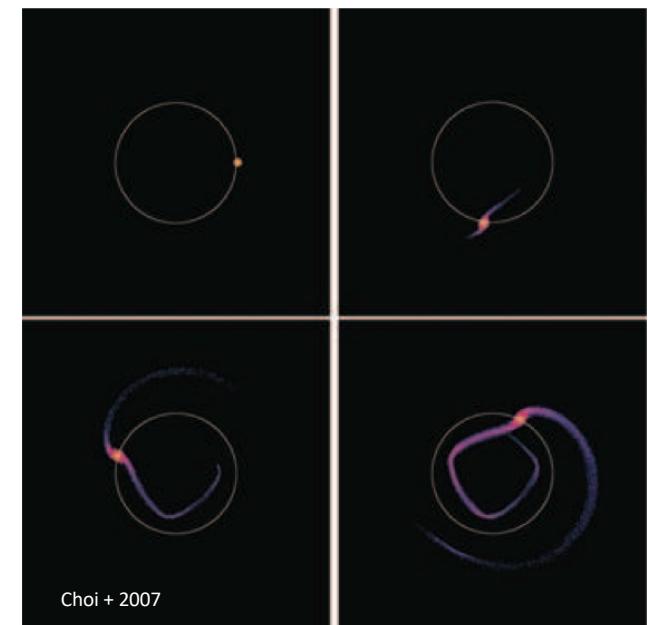
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