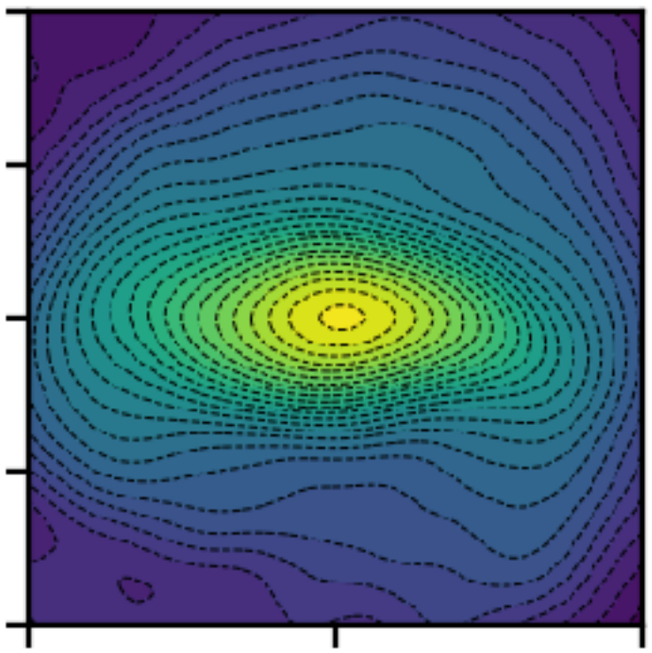
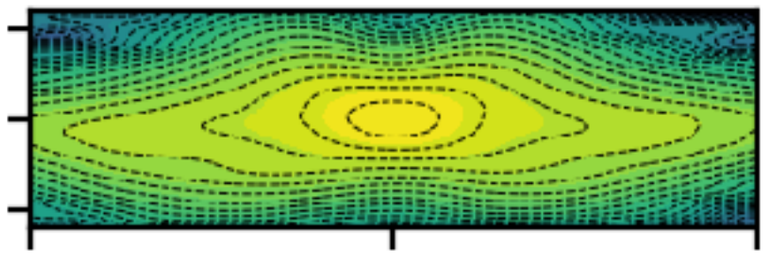




Evolution of Bars in Galaxies

Katherine Xiang, Johns Hopkins University
supervised by Dr. David Nataf &
Professor Lia Athanassoula, Aix-Marseille Universite

July 28th, 2018

Images taken by the Hubble Space Telescope.

Background: Bar formation

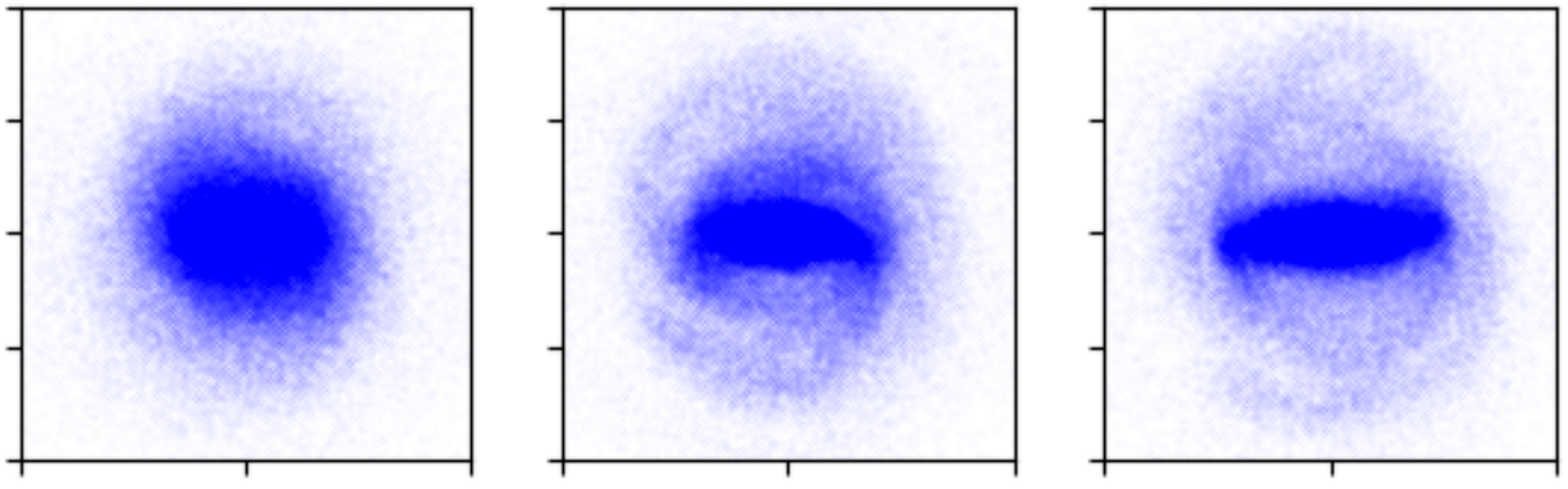
- Roughly 60% of spiral galaxies have bars (Buta et al., 2010)
- Significant proportion of all galaxies
- The Milky Way and Andromeda both have bars

- Bar formation is a cornerstone of galaxy evolution
- Bars form when instabilities cause deviation of orbits from circular paths (Athanassoula, 2005)

Face-on

Edge-on

N-body simulation specifics



Face-on

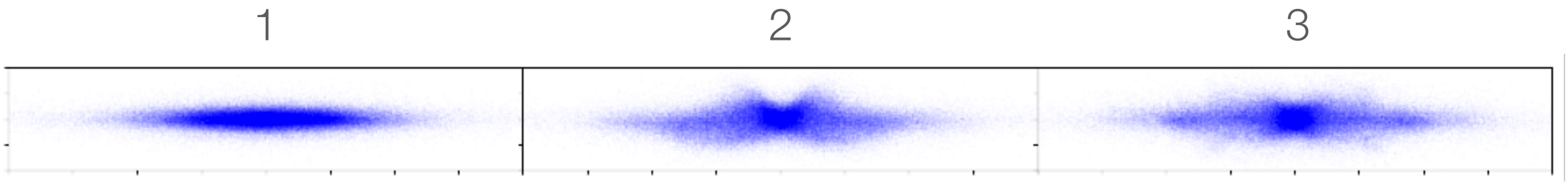
- *N*-body model used was developed by our collaborator Lia Athanassoula
  1. Luminous disk, 200,000 particles
     - Initialized w/ exponential drop-off radially, and a sech^2 drop-off in the z-axis
  2. Dark matter halo, 1,000,000 particles
     - Parameterized by halo scale lengths with a drop-off with radius squared

- Looking for kinematic signatures of a bar in the buckling phase, which is when the bar begins extending out of its galactic plane
- Want to eventually catch a bar buckling, observationally

How do bars form?

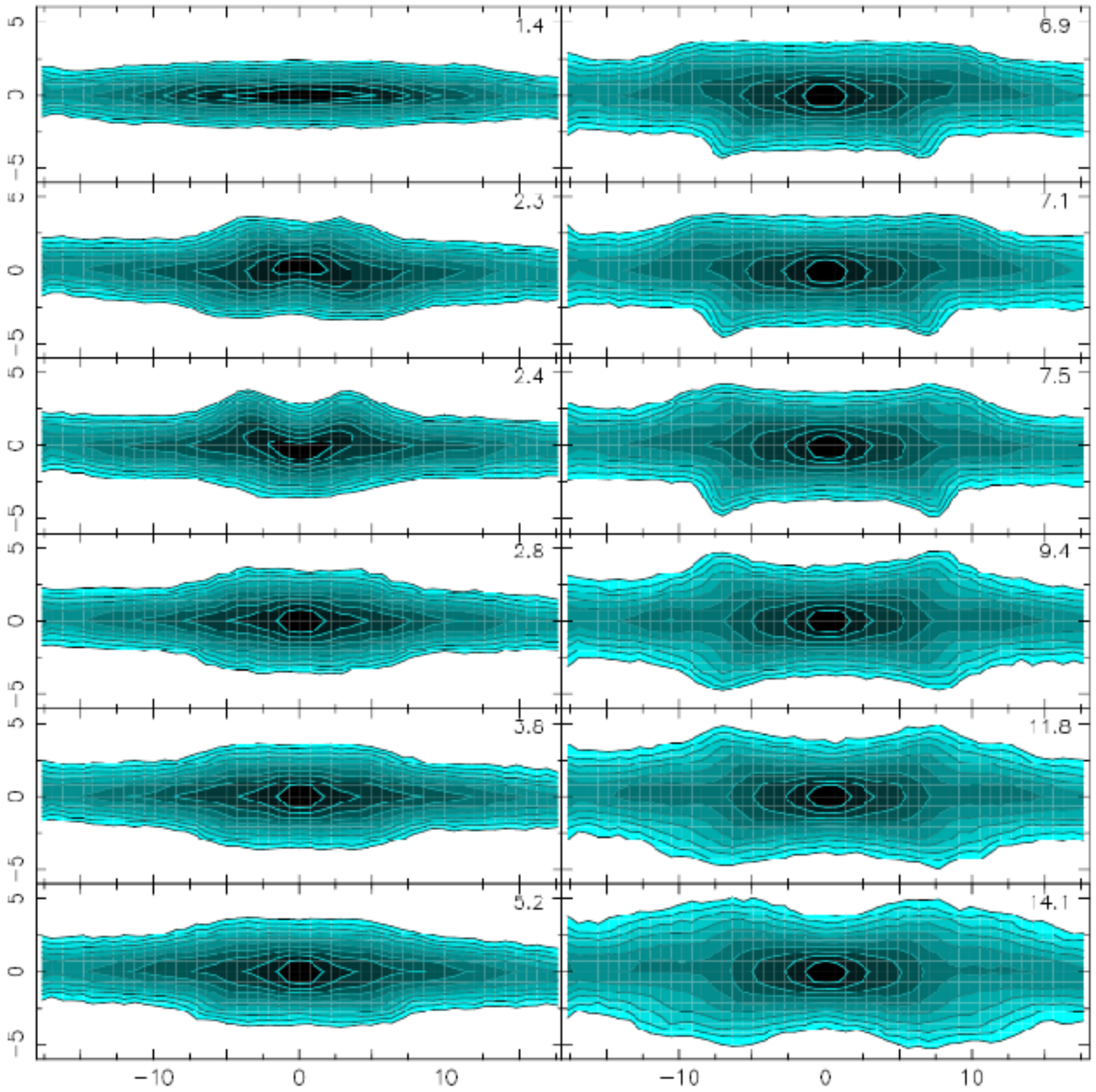
From 3D *N*-body simulations:

1. A weak, thin bar forms and sits within its galactic plane
2. The bar becomes unstable: it buckles and settles with an increased thickness and velocity dispersion
   A. During the buckling process, the bar is N/S asymmetric
   B. The N and S portions do not necessarily buckle at the same time
3. When seen edge-on, the bar is visibly thicker than its galactic plane, and appears boxy or peanut shaped



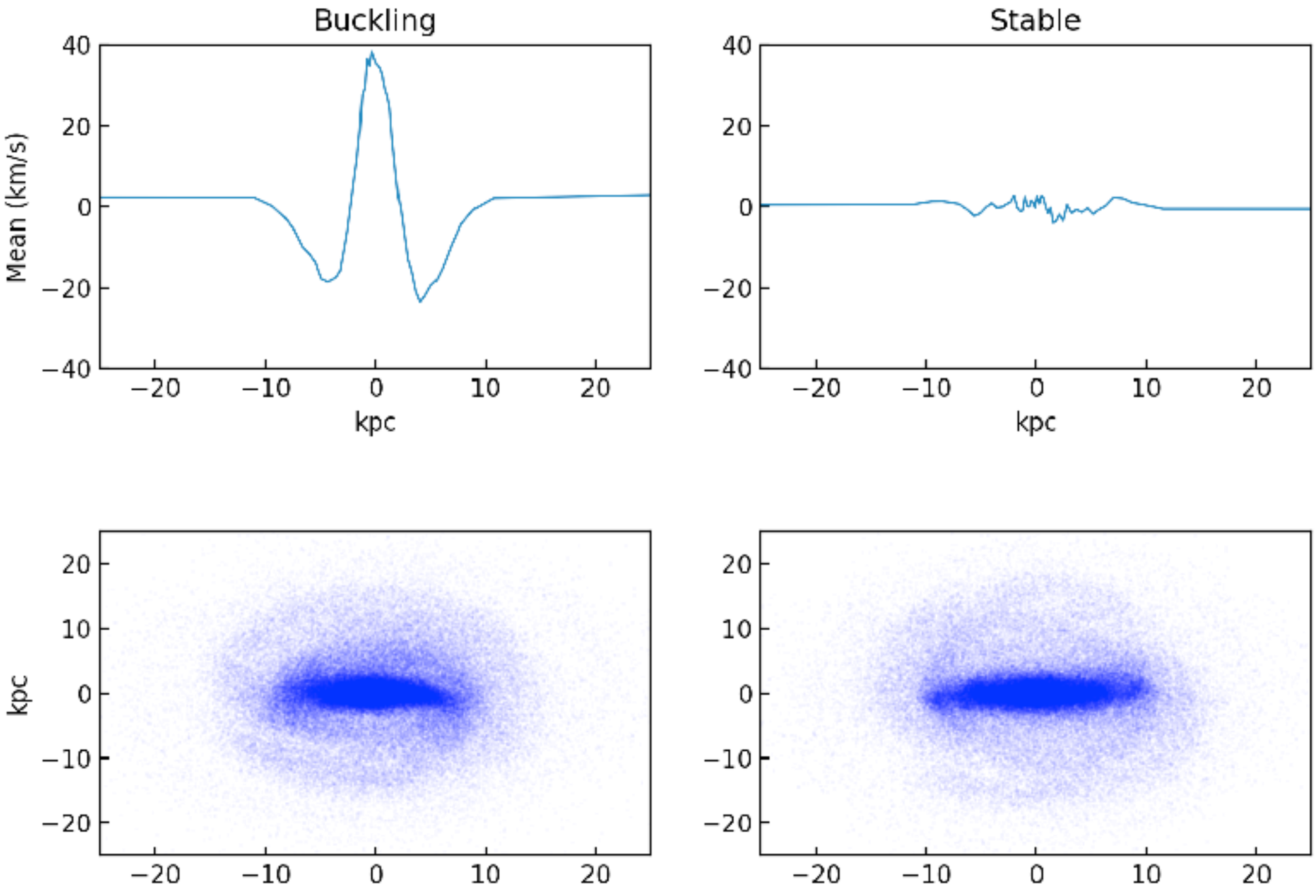
Edge-on

Edge-on



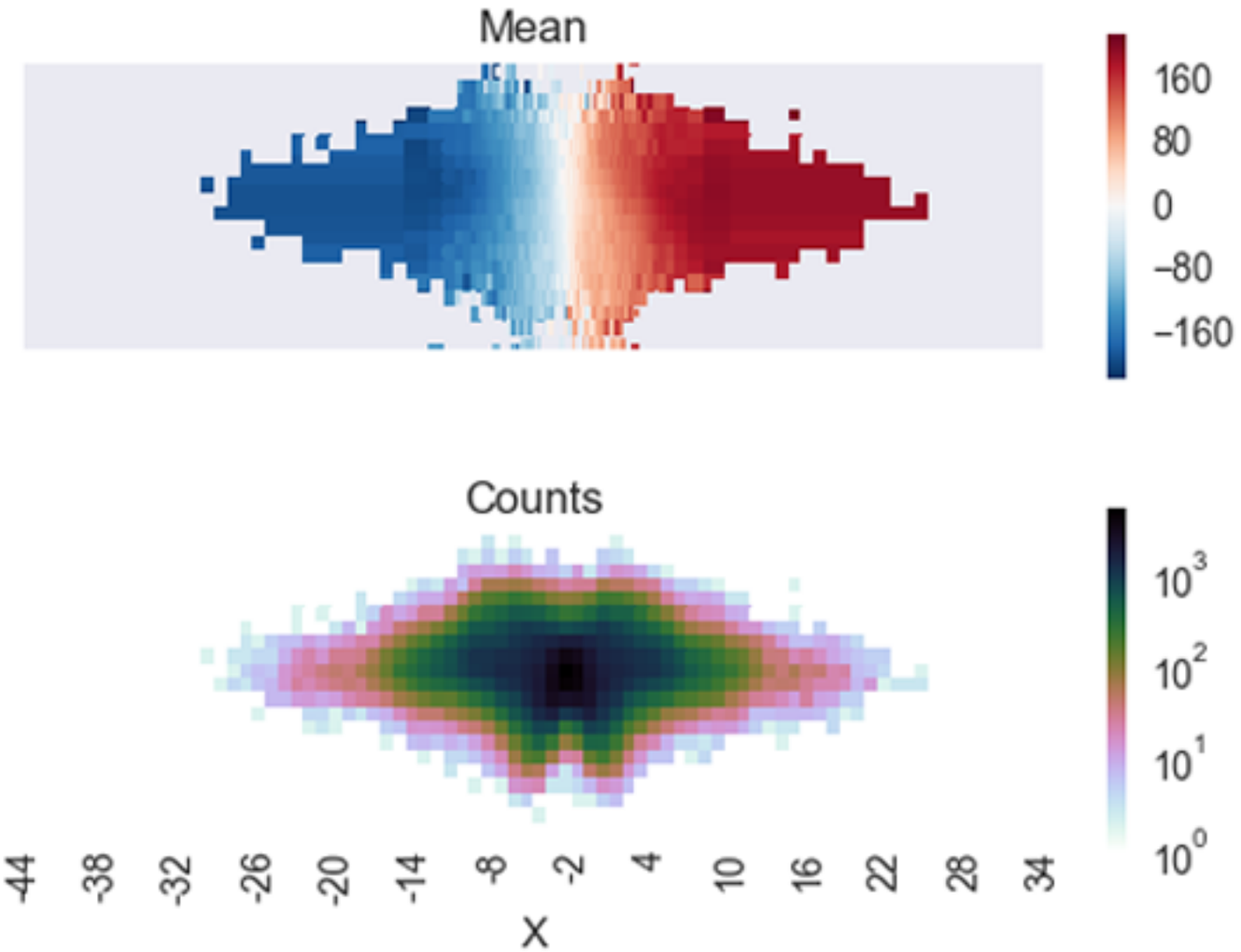
- Martinez-Valpuesta et al., 2006.

Signatures of the buckling instability

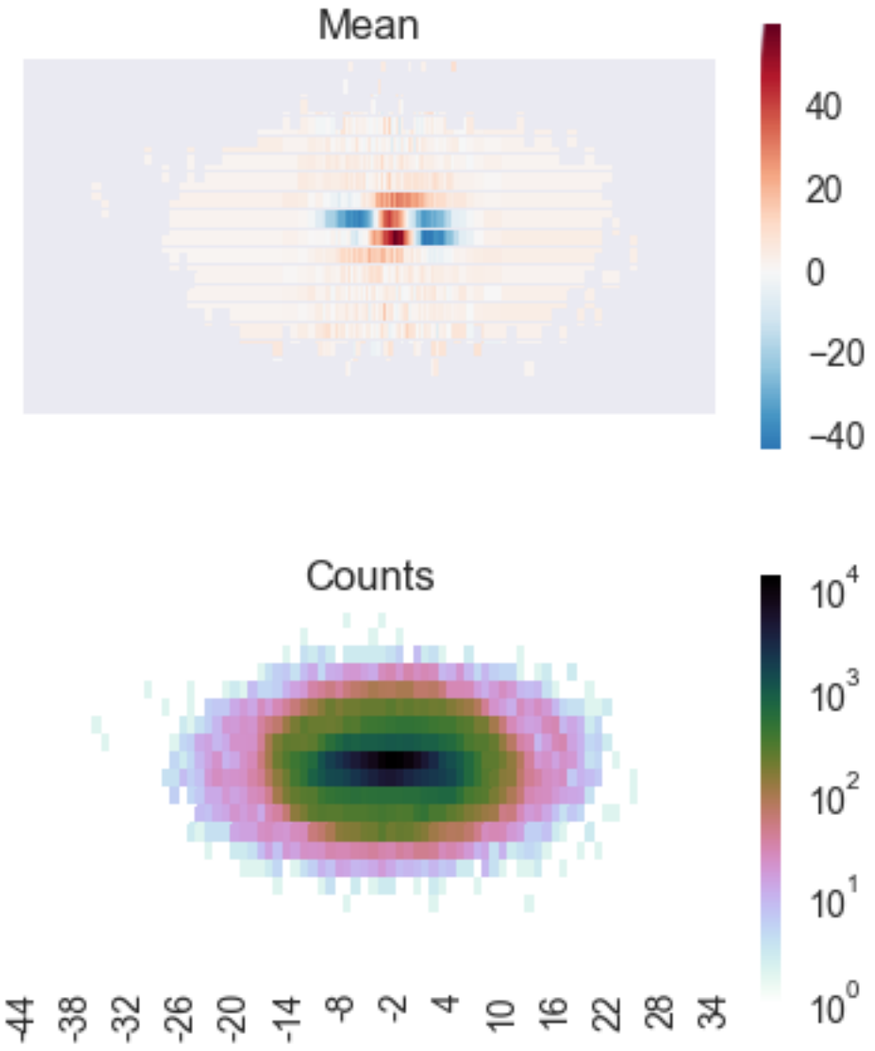


2D plots of line-of-sight velocity

Edge-on



Face-on



Observations

- MaNGA: Mapping Nearby Galaxies at APO, survey of 5000 galaxies, 800+ barred spiral galaxies
- ≈ 30 almost exactly face-on barred galaxies, statistically
- ≈ 350 that are ‘close enough’ to face-on

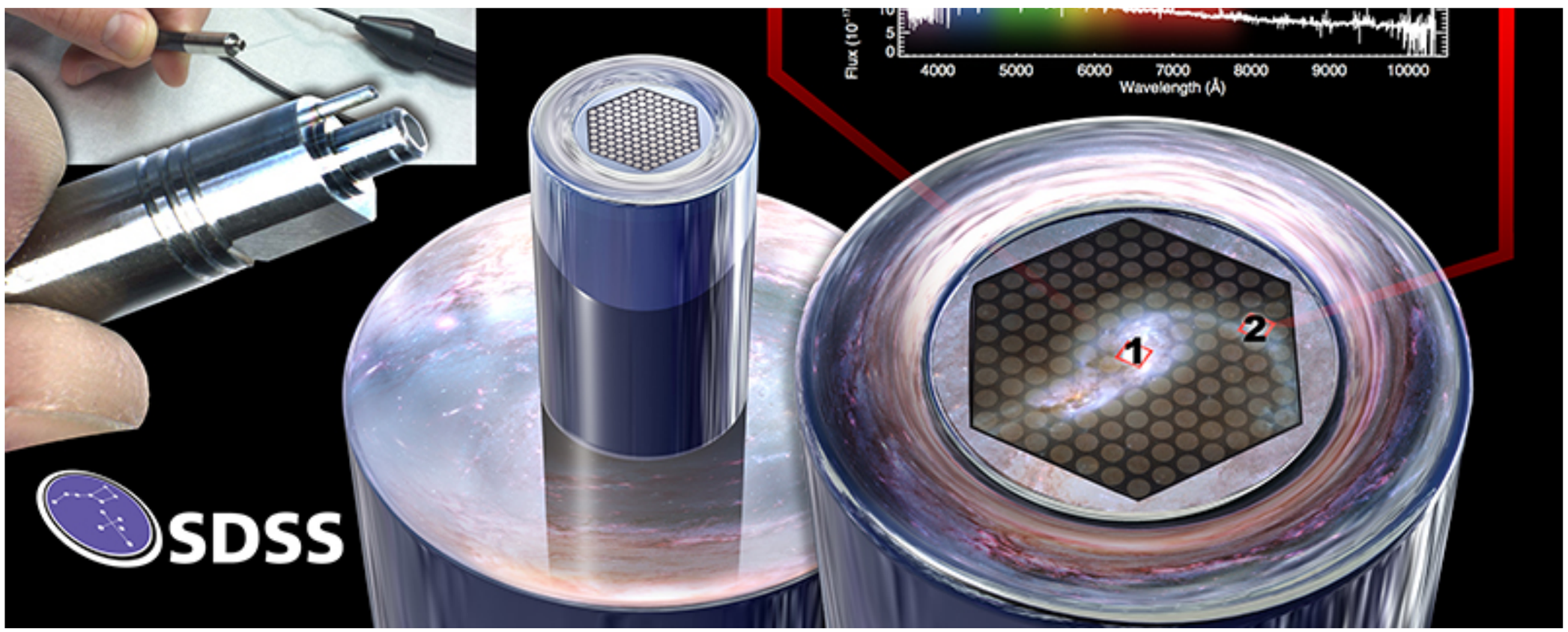
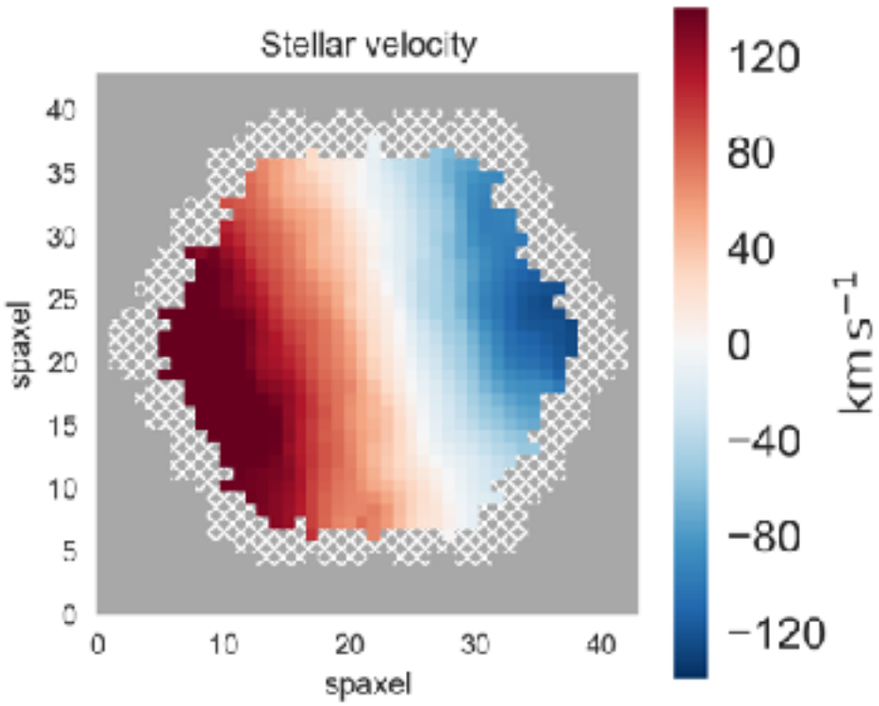


Image: Dana Berry / SkyWorks Digital Inc., David Law, and the SDSS collaboration


Stellar velocity
spaxel
spaxel
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30
40
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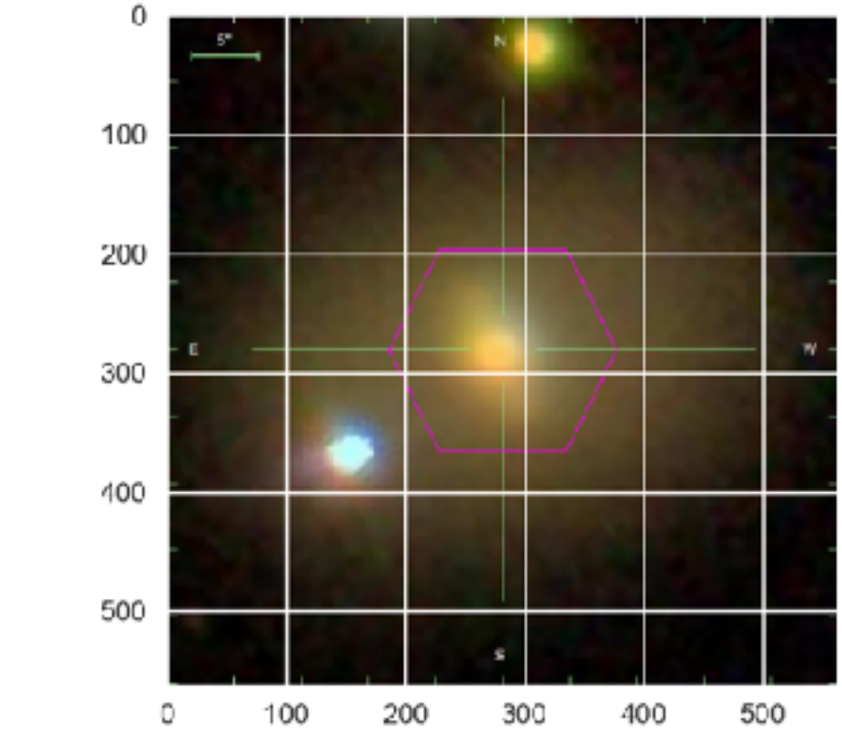
5
10
15
20
25
30
35
40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km s−1

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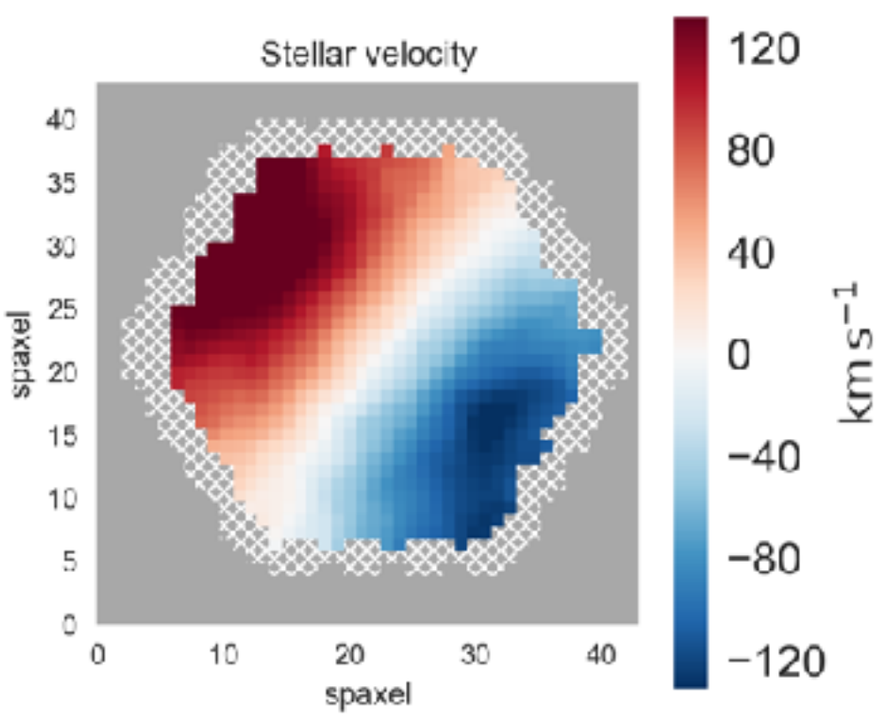
Stellar velocity
spaxel
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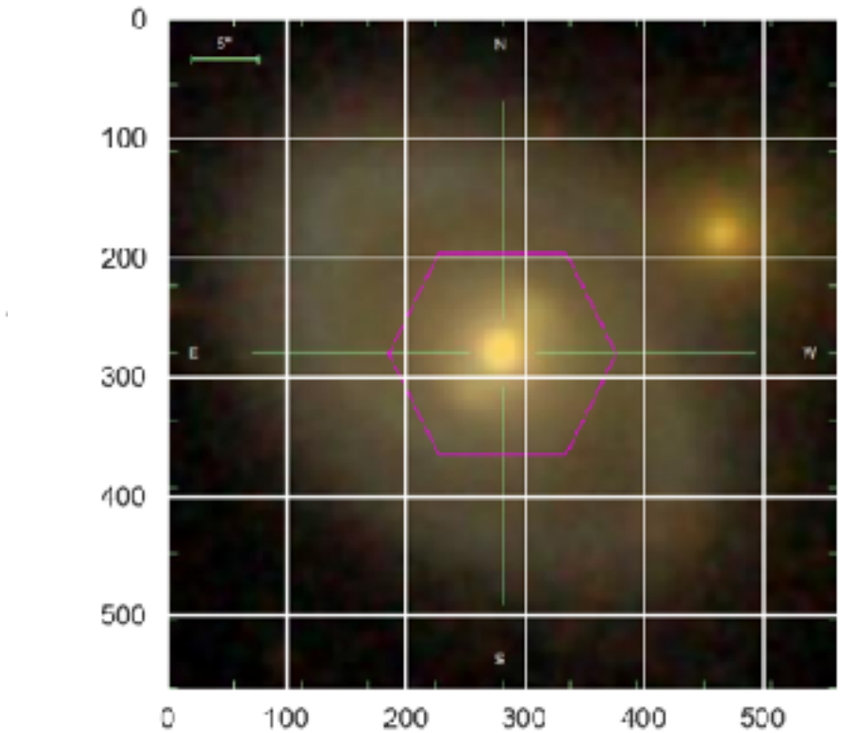
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−120
km s−1

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5"
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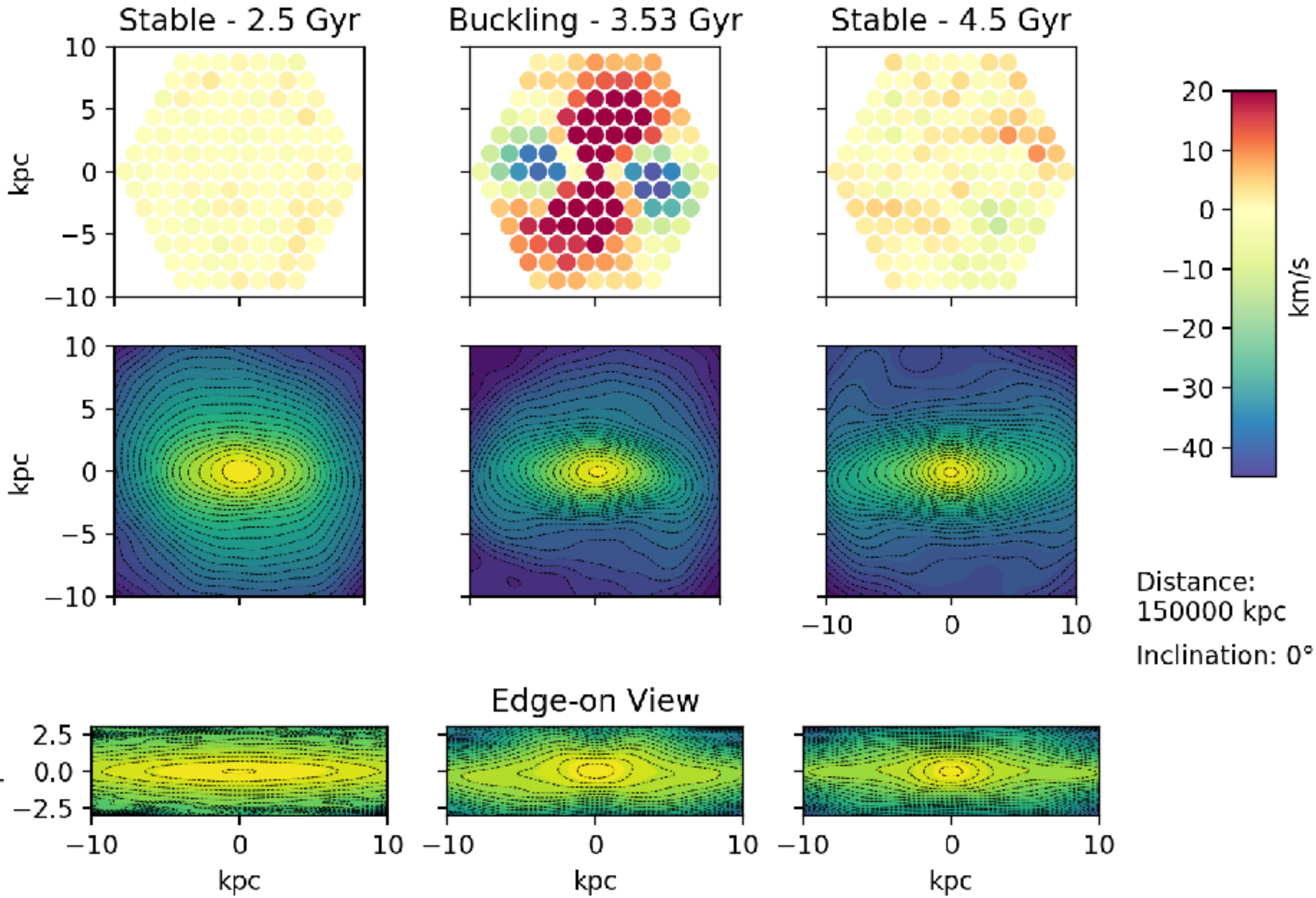
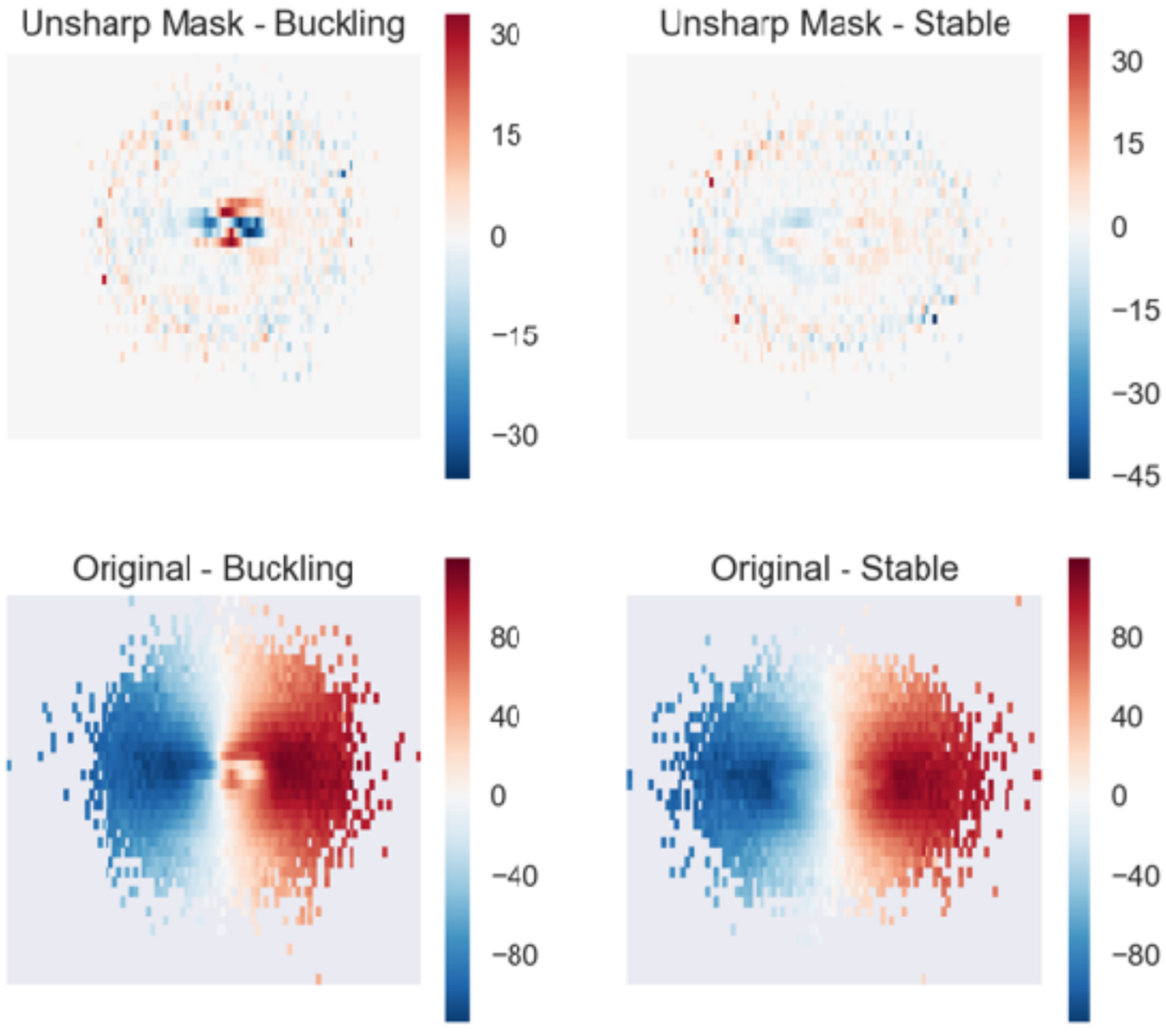
W
S

Face-on, simulation



Observations & Unsharp Masking (cont'd)



Thank you!

Line-of-sight Velocity

3.53 Gyr

90 Degrees Inclination

0 Degrees Inclination

Mean

Sigma

Skew

Counts

0

90

15 degrees inclination