The Internal Dynamics of Ultra-compact Dwarfs

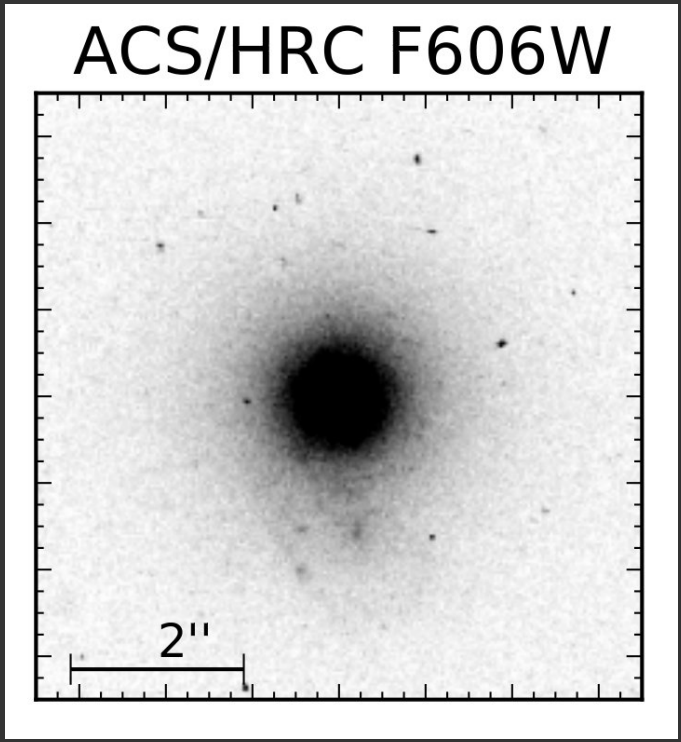
Matthias Frank

Astronomisches Rechen-Institut, Uni Heidelberg
ESO, Garching

UCD3: The first UCD with spatially resolved kinematics

(Frank et al. 2011 MNRASL, accepted)

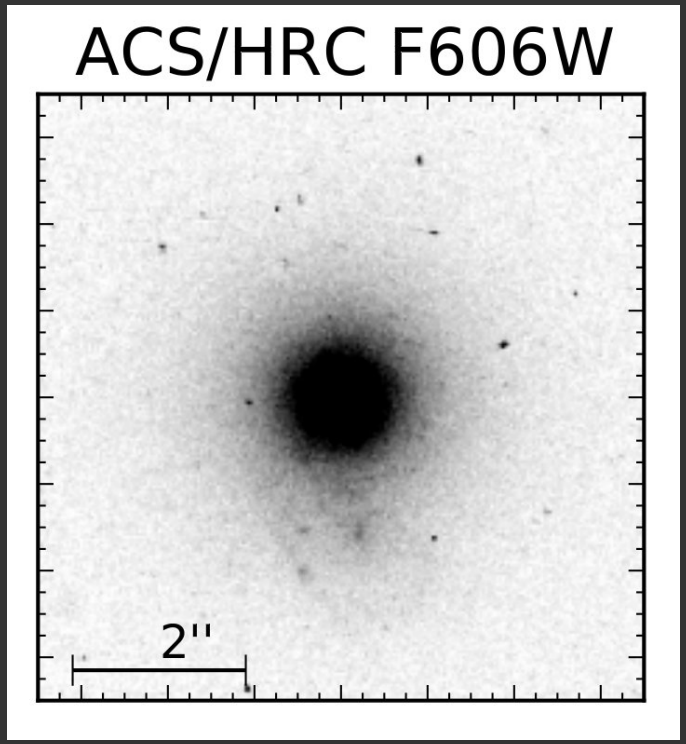
the brightest UCD in Fornax
m_V = 17.8 mag
M_V = - 13.6 mag
M ~ 8 x 10^7 M_o
extended, faint envelope



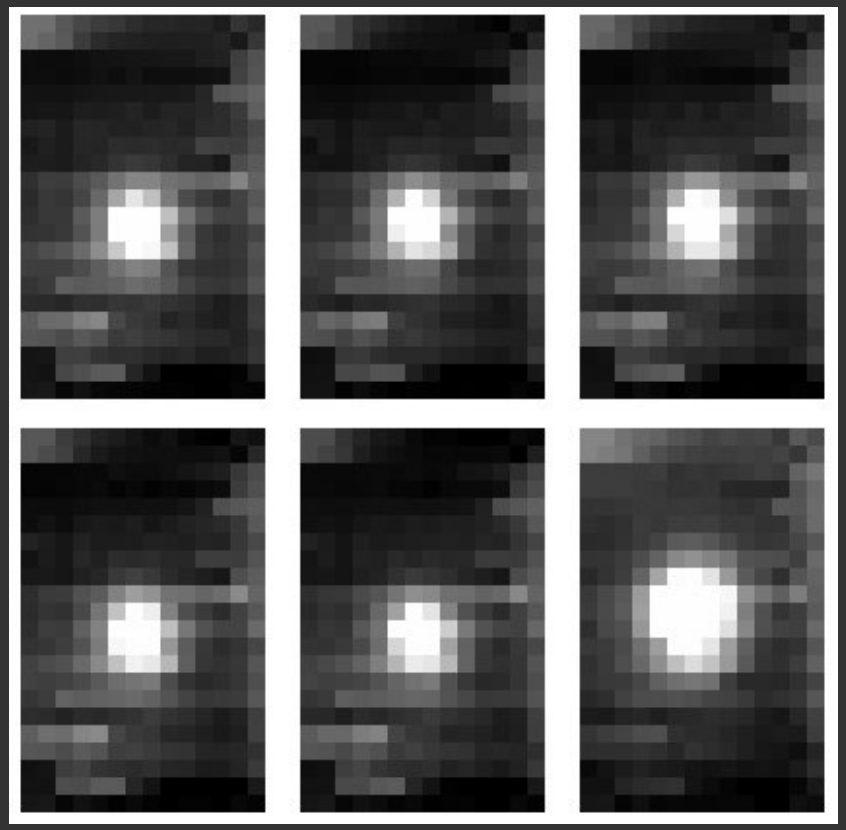
With:
Michael Hilker (ESO Garching)
Steffen Mieske (ESO Chile)
Holger Baumgardt (Queensland)
Eva Grebel (Heidelberg)
Leopoldo Infante (PUC)

Non-AO integral-field spectroscopy at the resolution limit

the brightest UCD in Fornax
m_V = 17.8 mag
M_V = - 13.6 mag
M ~ 8 x 10^7 M_o
extended, faint envelope



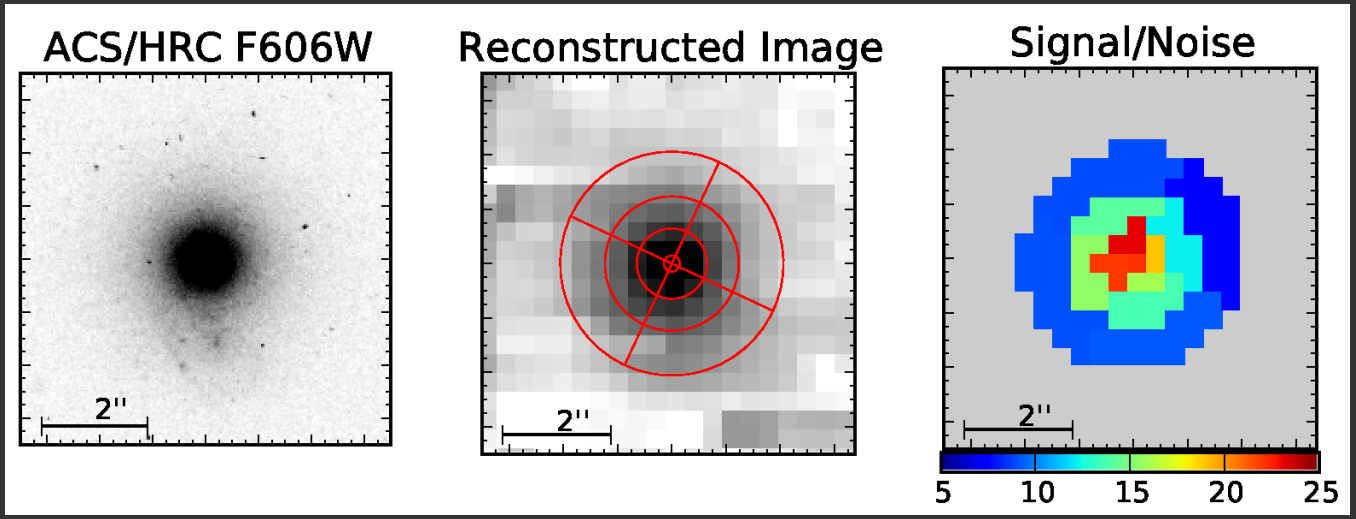
ARGUS IFU (VLT/Flames) spectra
taken in LR04 (500 – 580nm), R~9600



UCD's half-light diameter: ~1.4 arcsec
Seeing: ~0.6 arcsec FWHM
Spatial sampling: 0.52 arcsec per spaxel

Measuring the kinematics

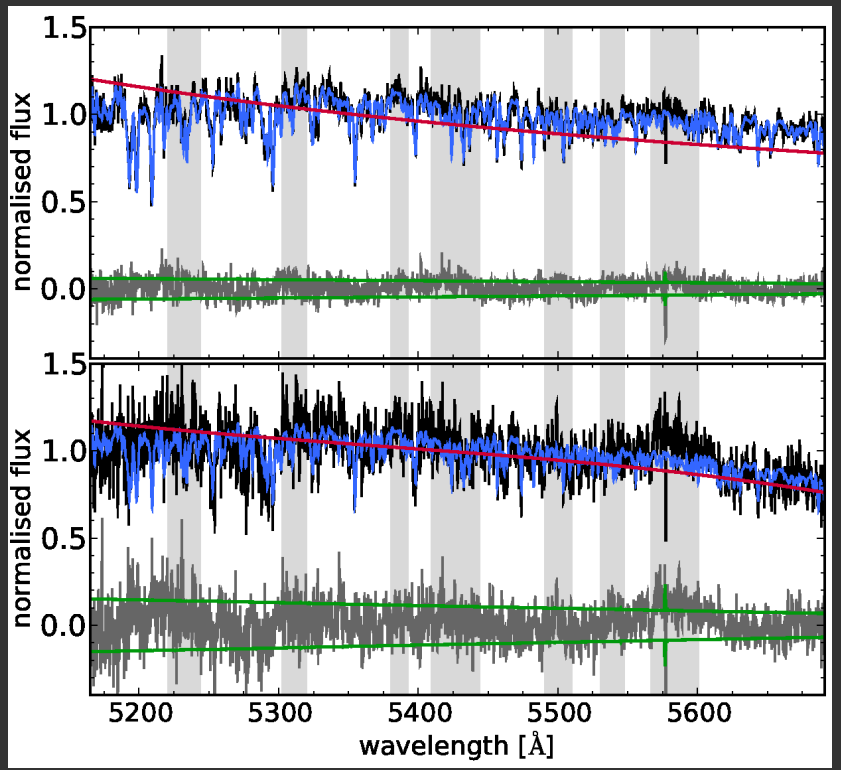
Merged data cube (slightly spatially over-sampled) & binned



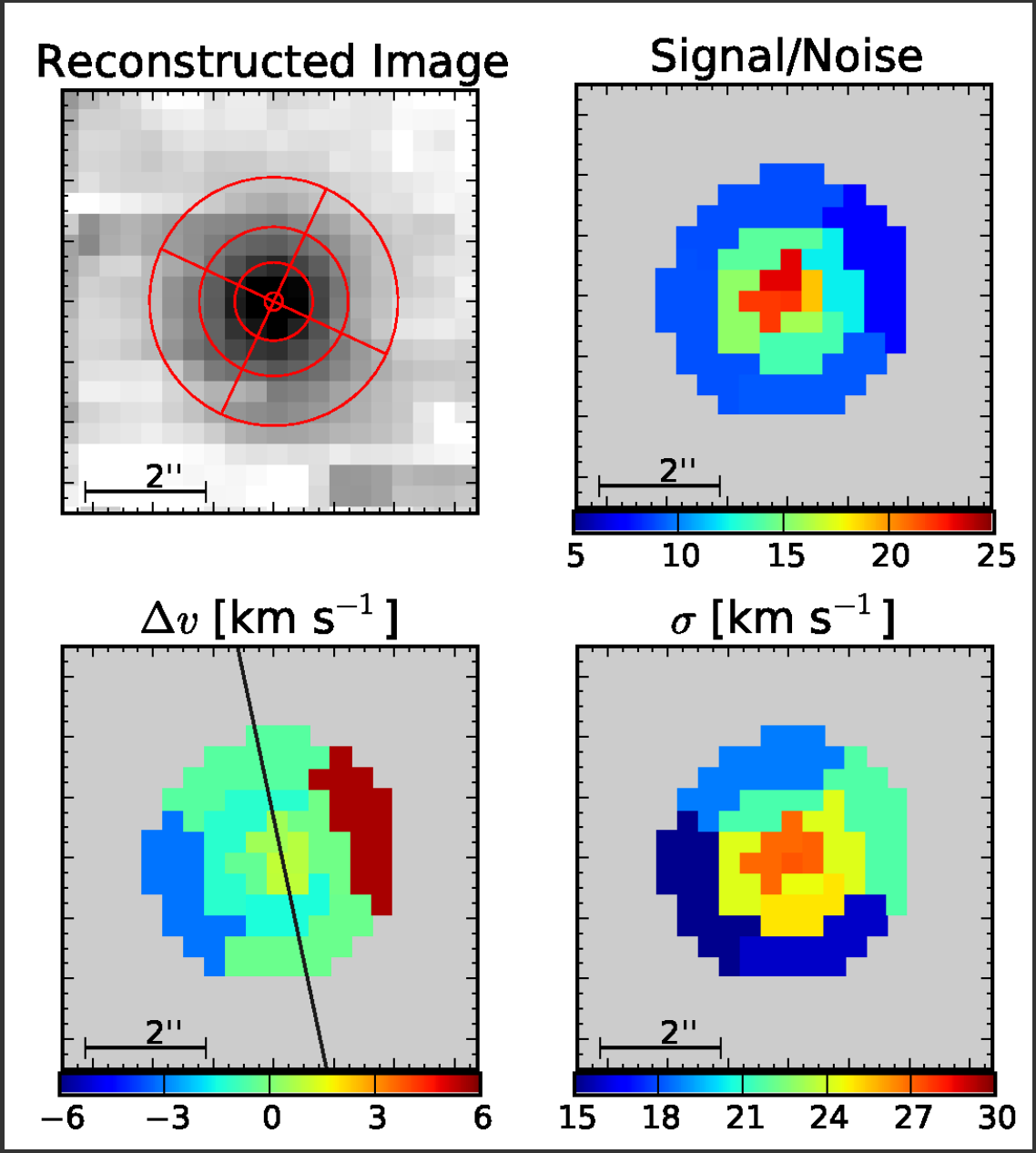
central spaxel

Velocity + velocity dispersion
via ppx-fitting (Cappellari & Copin 2004)
of UVESPOP stellar templates (Bagnulo et al. 2003)

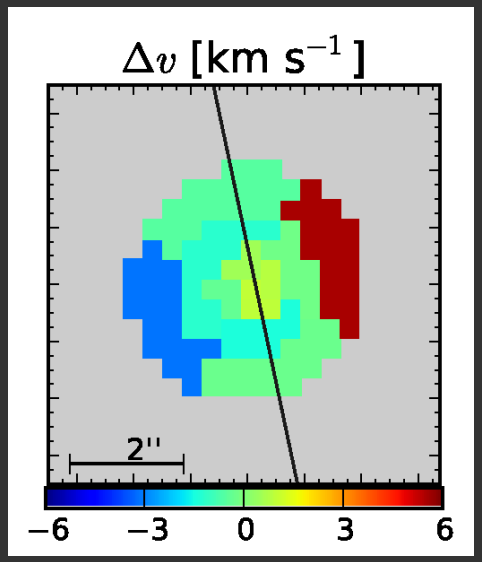
worst case

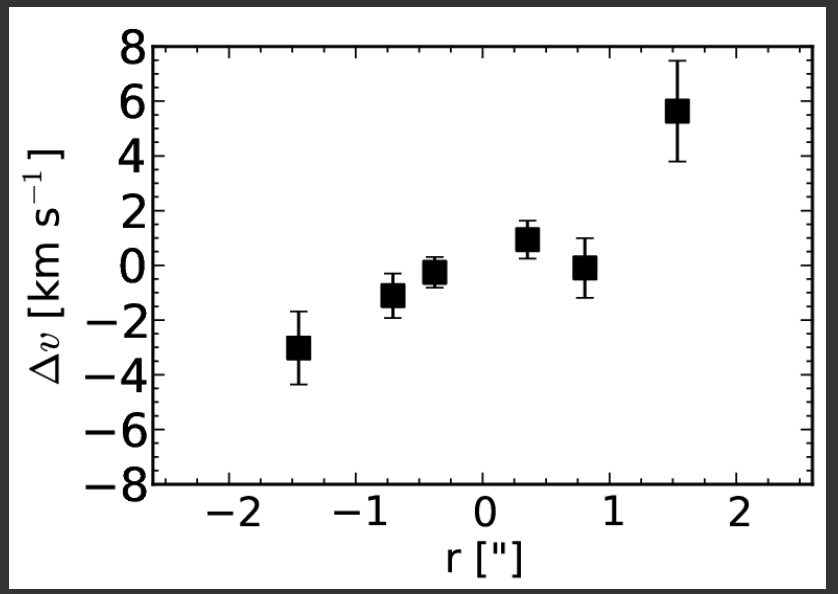


UCD3: Kinematics



Rotation

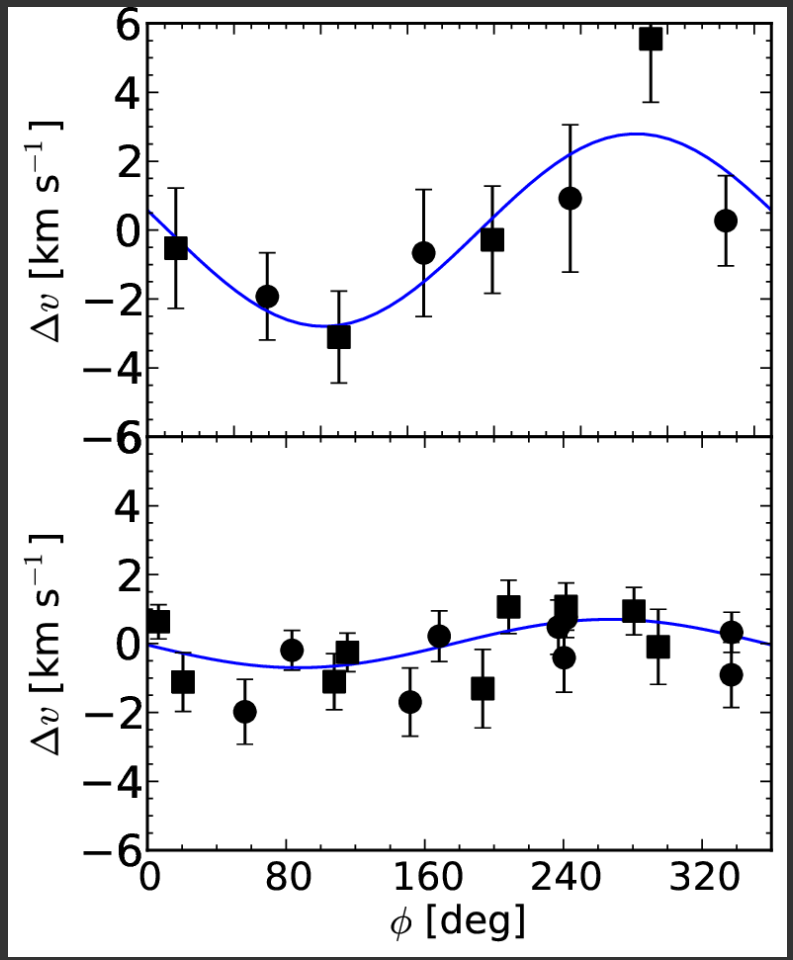




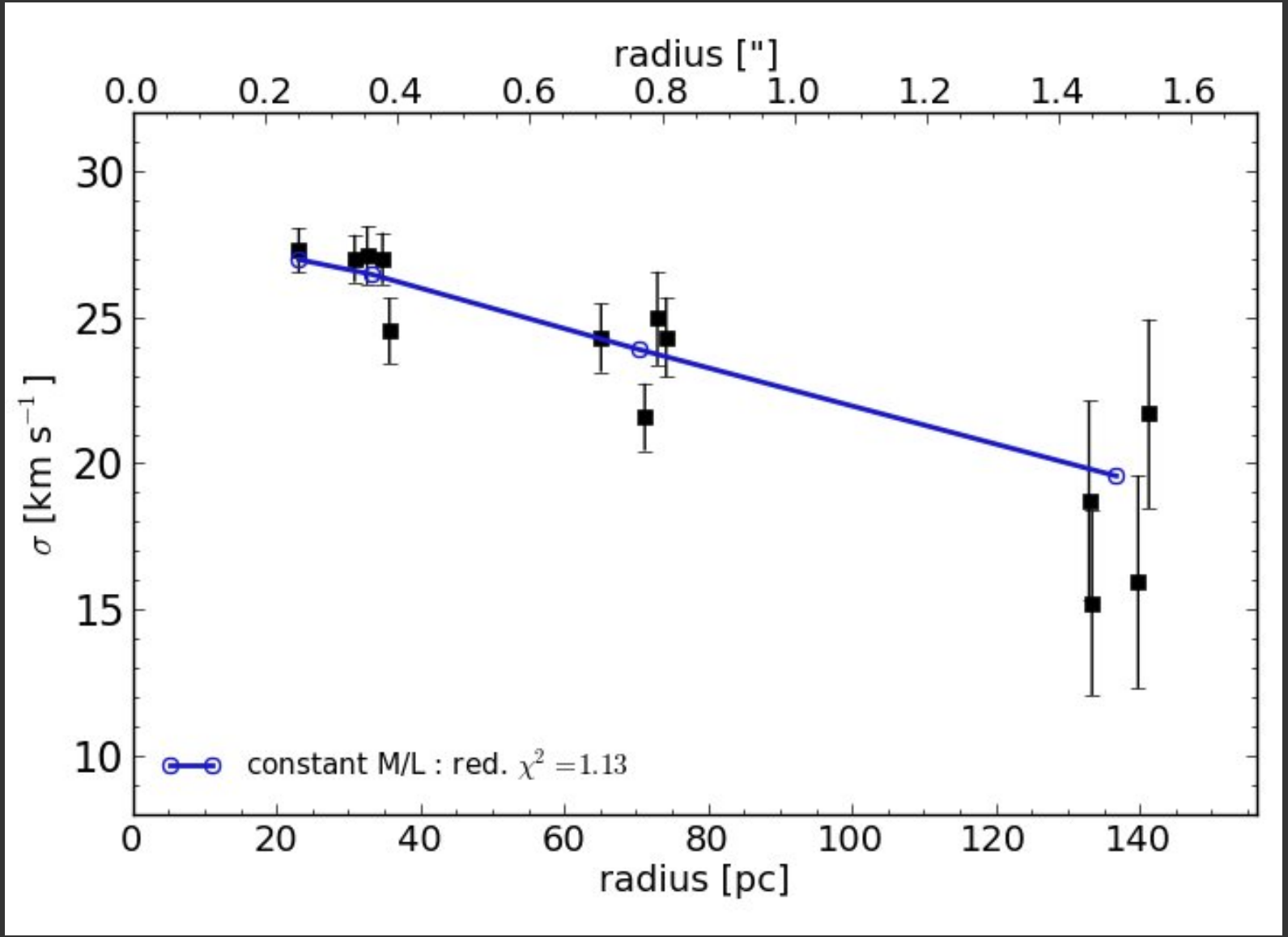
Rotation curve

Outer (r>1.2”)

Inner (r<=1.2”)



UCD3 Dispersion Profile



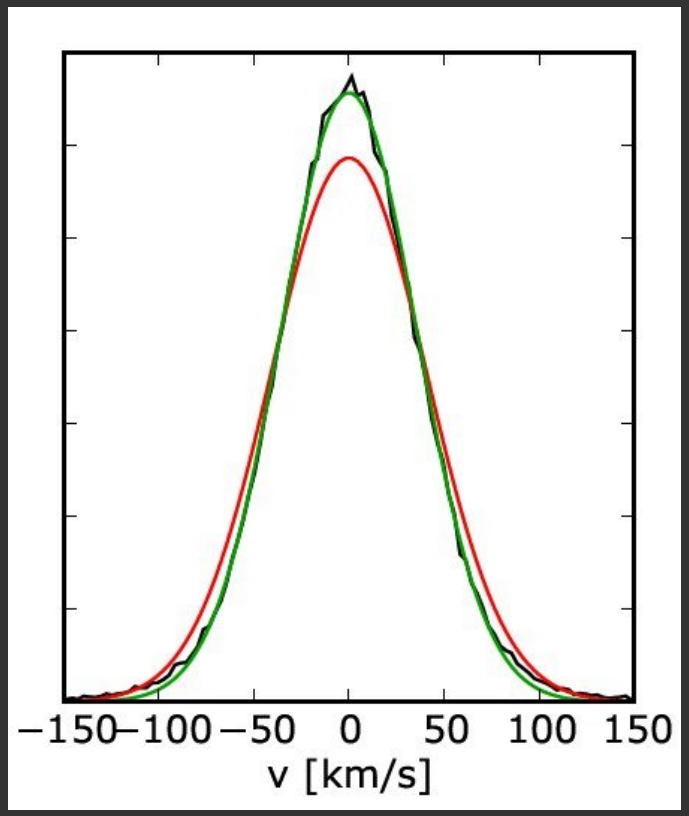
simplest possible model: Isotropic, mass follows light

best-fitting M/L_V = 3.6 ± 0.3 or M = 8.2 ± 0.7 x 10^7 M_{sol}

Mass Modelling

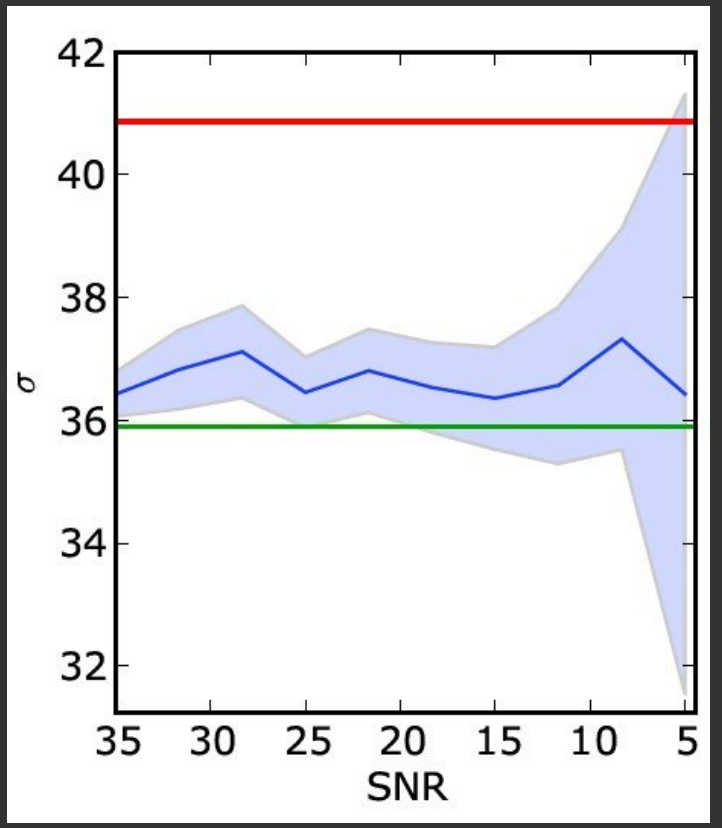
Based on HST light profile & assuming isotropy
- deproject density, calculate potential
- populate with test particles a N-body representation of the UCD (Hilker et al. 2007)
- PSF convolution, integrate over binning annuli

Model LOSVD



Artificial Spectra
+
Kinematics
extraction

Recovered dispersion



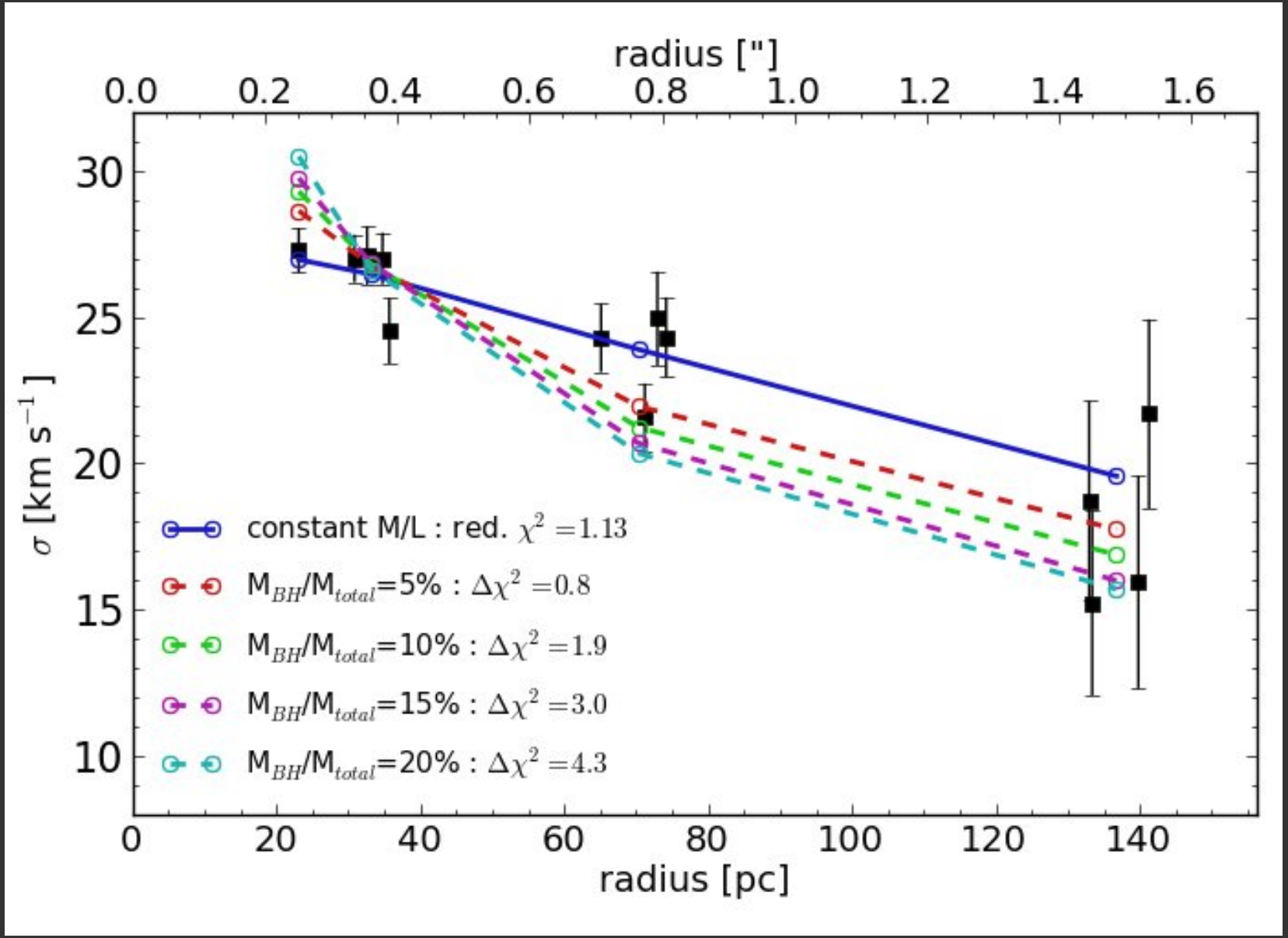
Massive Black hole models

Why Black Holes?
Coexistence of nuclear clusters and BHs of similar masses
(Graham & Spitler 2009, Nadine Neumayer's talk)
but: are there nuclei + BHs massive enough?

or

Merrit et al. 2009: Recoiling SMBHs with associated star clusters?

Massive Black hole models



BH models fit worse, but BH of 5% of the mass compatible with data at 1-σ

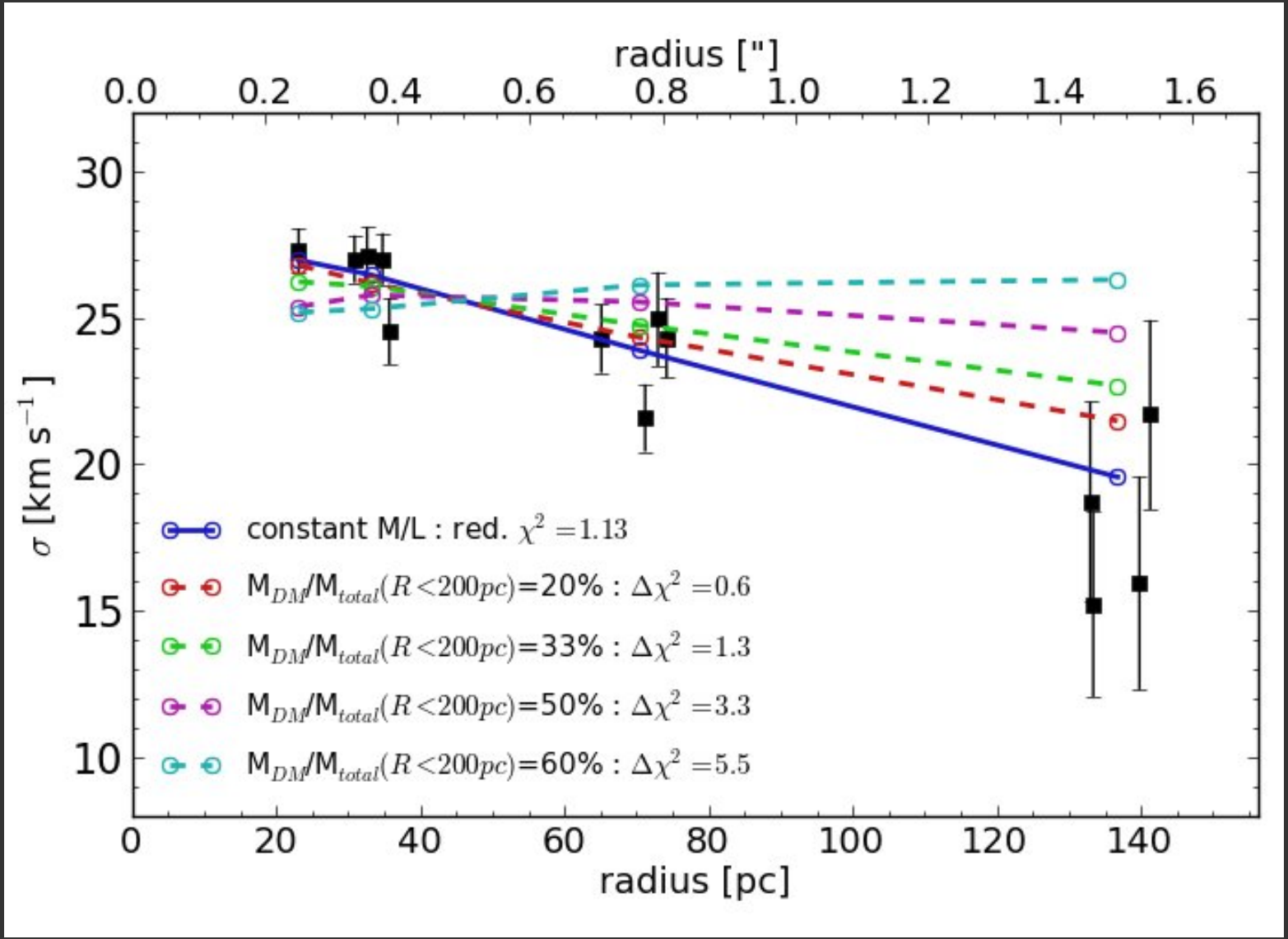
Dark Matter Models

Dark Matter?

but: very high DM densities needed

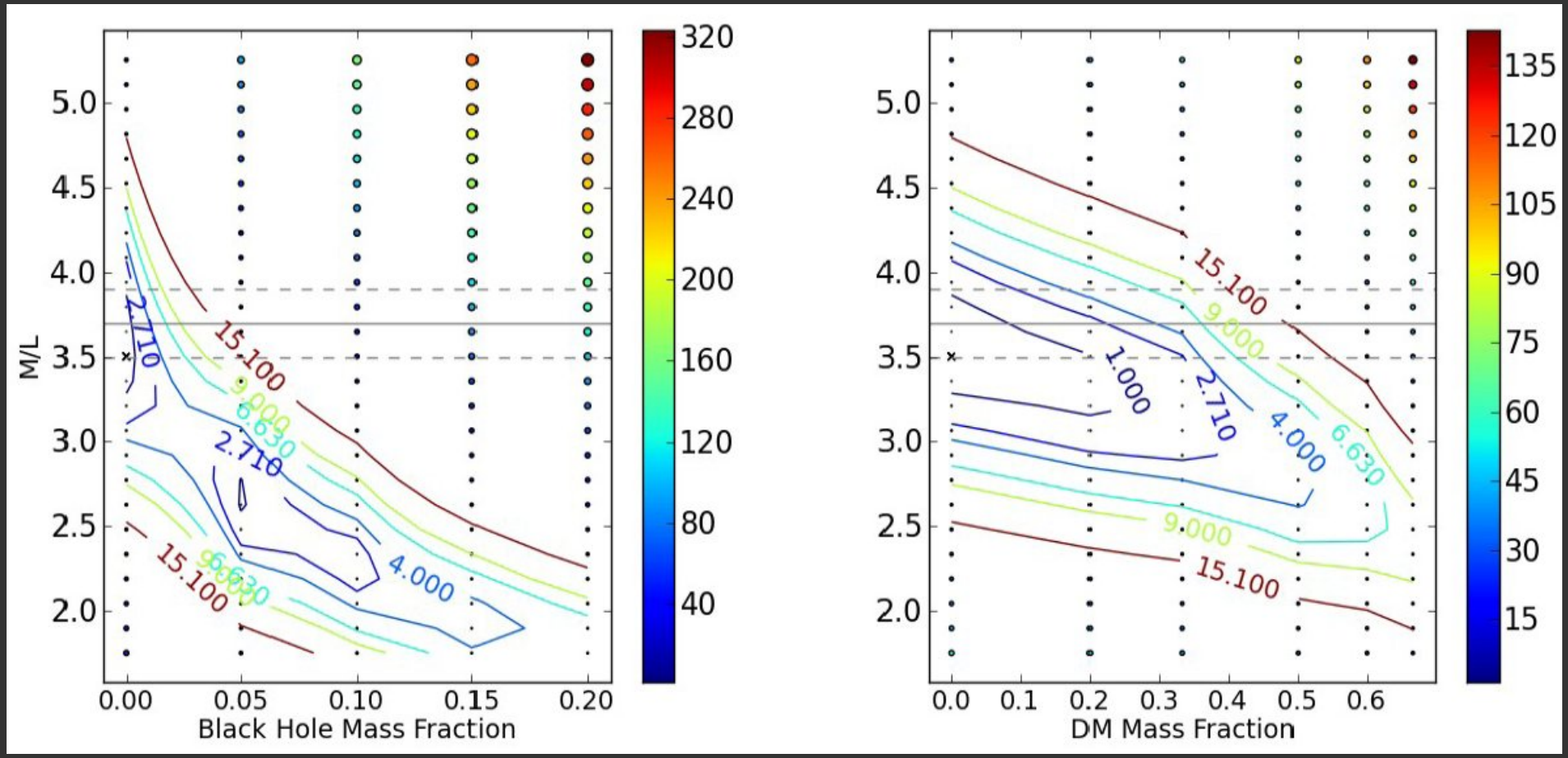
Possible solution: in-fall of gas into progenitor nucleus, enhancing the central DM concentration
(Baumgardt & Mieske 2008, Goerdt et al. 2008)

Dark Matter Models



DM models fit worse, 33% DM mass inside 200pc compatible at the 1-σ level

Dynamical vs. stellar population M/L



Stellar population parameters:
(Chilingarian et al. 2011)
[Fe/H] ~ -0.2 dex, ~12 Gyrs
→ $M/L_V = 3.7 \pm 0.2$

→ **Perfect agreement** with mass follows-light model ($M/L_V = 3.6 \pm 0.3$)

Spatially resolved kinematics of UCDs

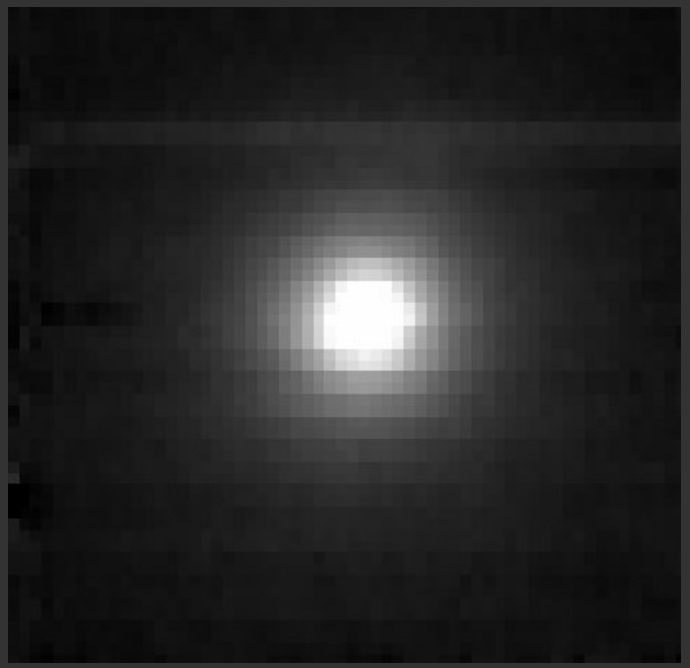
UCD3:

- UCD3 just a massive star cluster?
- Resolving the most extended & luminous UCDs with seeing-limited IFUs is feasible!

(see astro-ph in a few days..)

Outlook: SINFONI LGS observations of the “M59 compact Object”

- Much higher spatial resolution
- Lower spectral resolution
- Observations awaiting completion



With:
Steffen Mieske (ESO Chile)
Michael Hilker (ESO Garching
Andrés Jordán (PUC)
Igor Chilingarian (Strasbourg)