Structure components of galaxies: morphology and internal dynamics

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TOPICS:

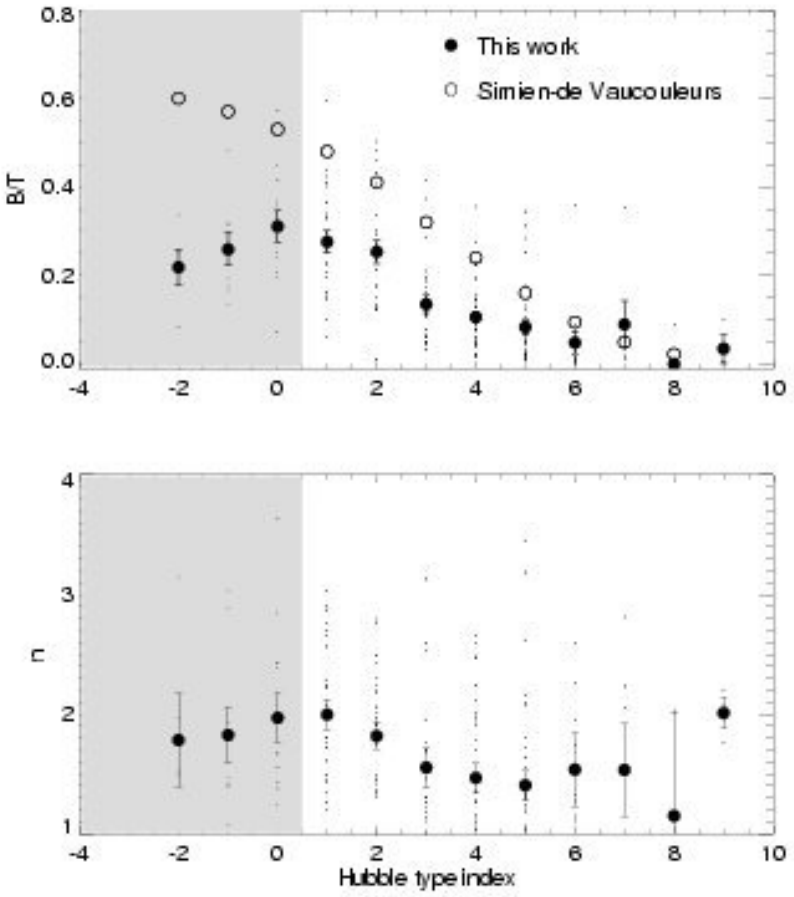
1) Morphology: Properties of bars, lens/ovals, rings, bulges; how they are connected to secular evolution of galaxies.

2) Internal dynamics: Estimation of gravity potentials;

- $\Rightarrow$ **utilization in study of bar-spiral correlations**
- $\Rightarrow$ **utilization in simple pattern speed simulations**

CHARACTERIZATION OF STRUCTURAL COMPONENTS

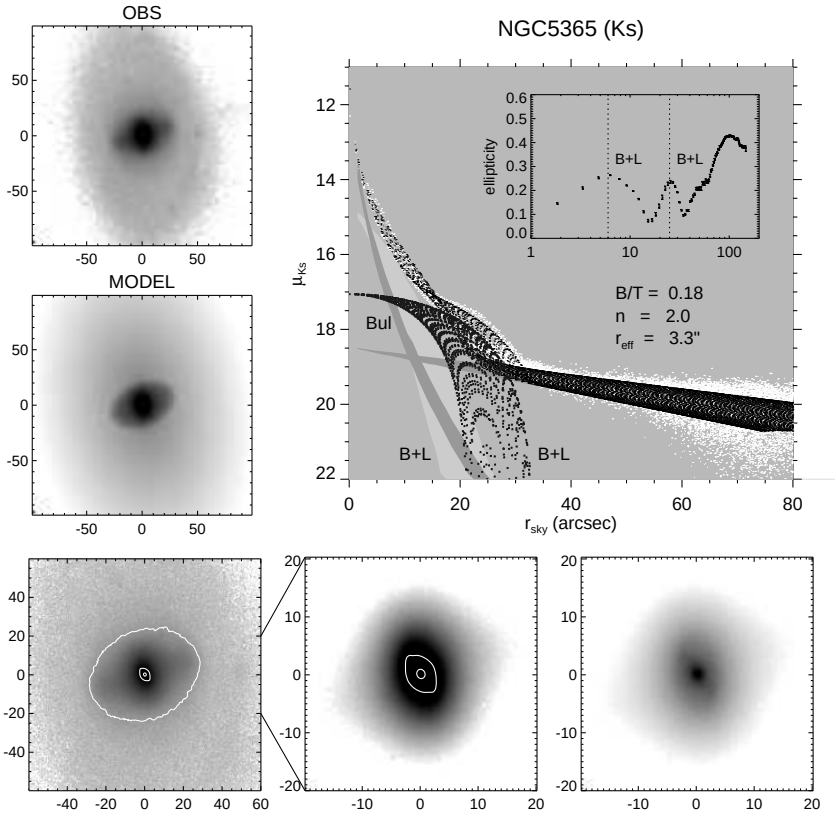
- **First priority: scaling relations between bulge and disk parameters barrow clue for formation processes.**
- **Classical vs pseudo-bulges? (however, requires also kinematics!)**



OSUBSGS + NIRS0S (just part of it)

Laurikainen et al. 2007 MNRAS

- **Fitting multiple oval components in S0's (NIRS0S sample)**



(Laurikainen, Salo, Buta, Knapen 2009 ApJL 692, 34)

Formation of ovals: evolved bars?

Formation of multiple bar/lens systems?

ESTIMATION OF GRAVITY FIELDS WITH NIRQB

- **NIRQB: code for calculation of FT,FR in the disk plane**

  Assumes: near-IR light traces mass (constant M/L);

  Vertical scale height h_z (tied for example to h_r or R_{K20})

  Utilizes azimuthal Fourier decomposition + polar integration

  $\Rightarrow$ no spurious forces in the outer disk due noise

  $\Rightarrow$ easy to accomodate radially variable $M/L, h_z$

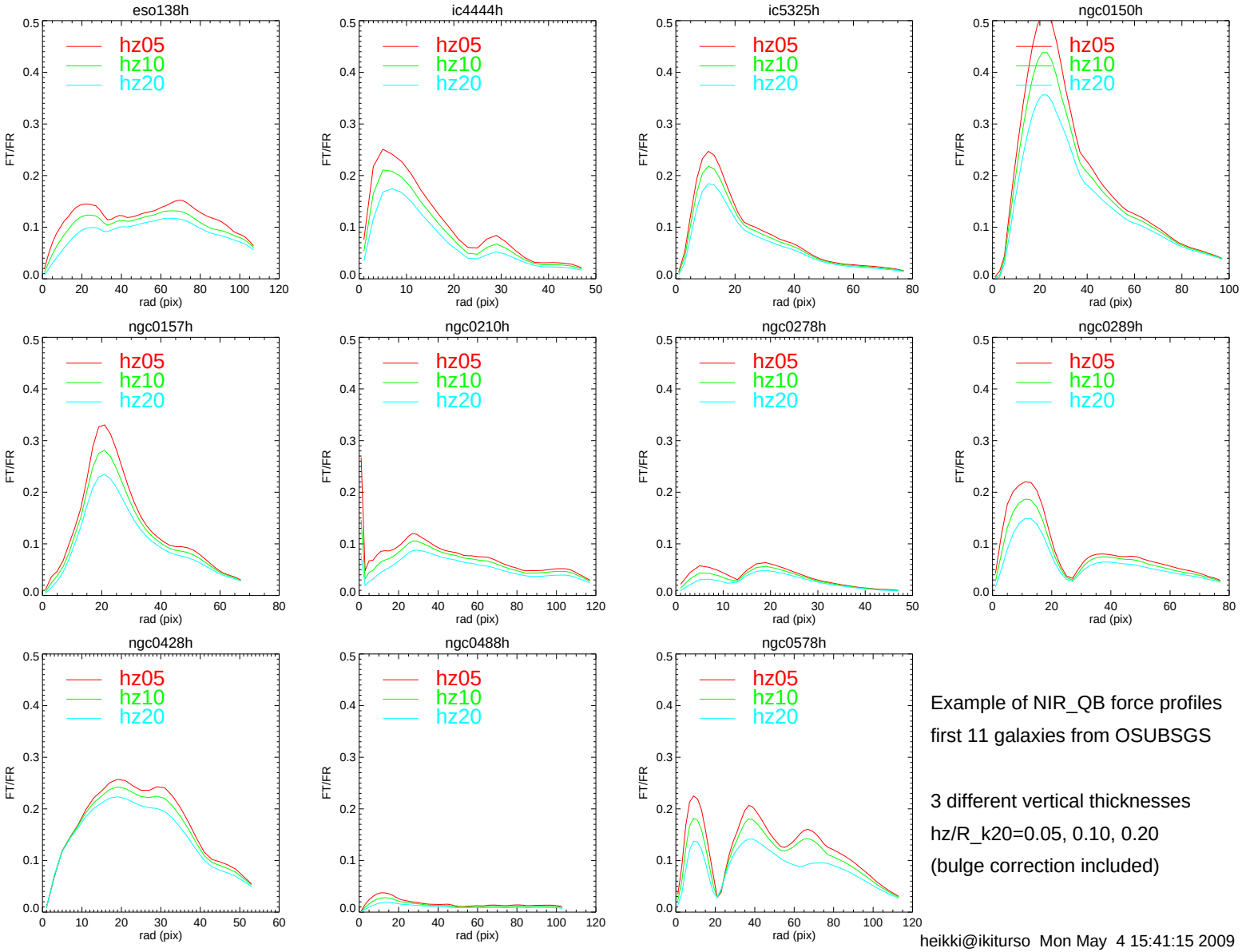
  Can use bulge models from decompositions to eliminate the artificial forces arising due to bulge deprojection stretch

- **We have applied NIRQB to 2MASS, OSUBSGS, NIRS0S, AAT samples**

  Automatic procedure, fairly robust $\Rightarrow$ could be part of the pipeline III

  Radial profiles of $Qt(R) = \max(FT)/ < FR >$, max of Qt etc.

Uncertainty due unknown h_z fairly small



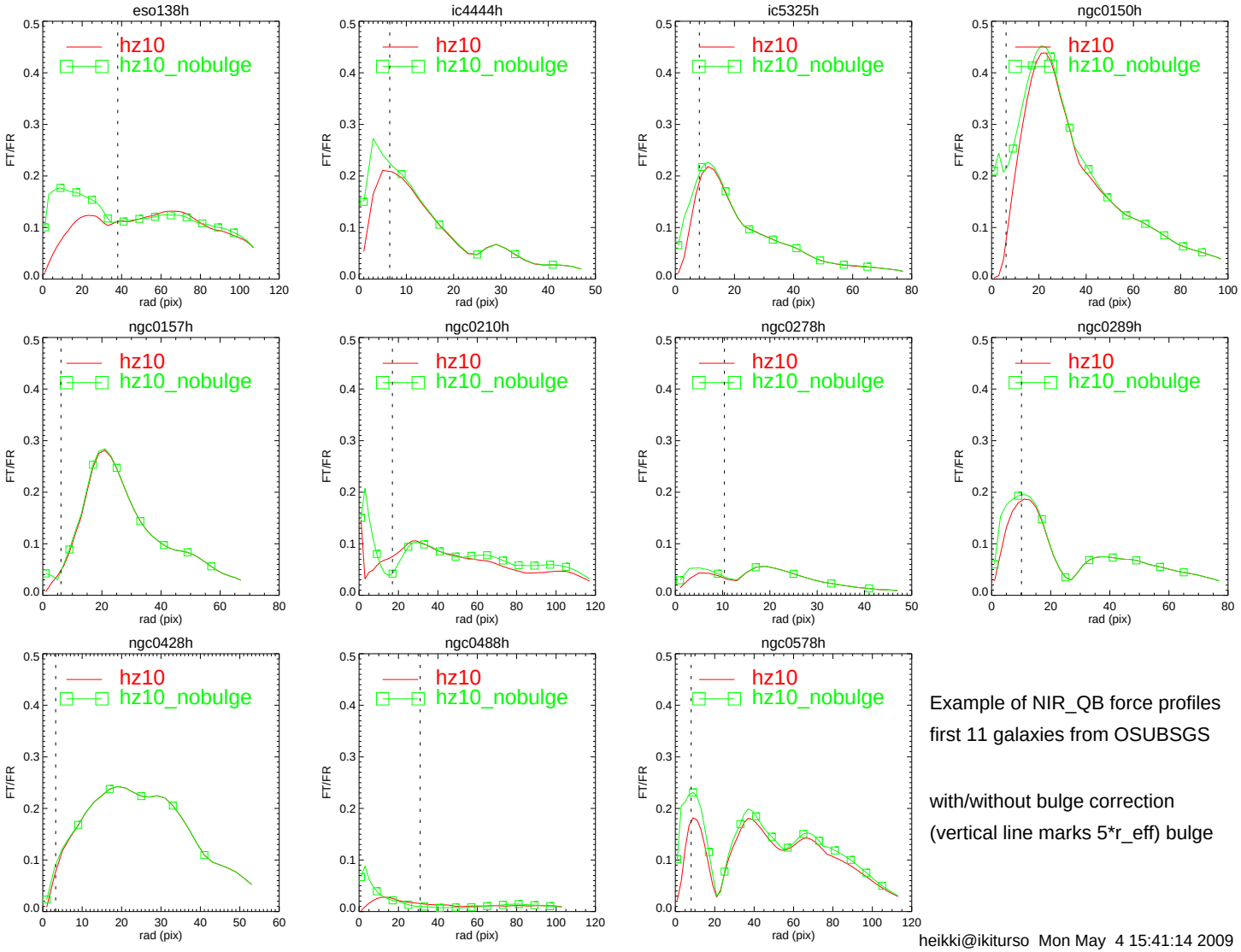
Example of NIR_QB force profiles
first 11 galaxies from OSUBSGS

3 different vertical thicknesses
hz/R_k20=0.05, 0.10, 0.20
(bulge correction included)

heikki@ikiturso Mon May 4 15:41:15 2009

Special bulge treatment important only at central regions

⇒ need not wait decompositions



Example of NIR_QB force profiles
first 11 galaxies from OSUBSGS

with/without bulge correction
(vertical line marks 5*r_eff) bulge

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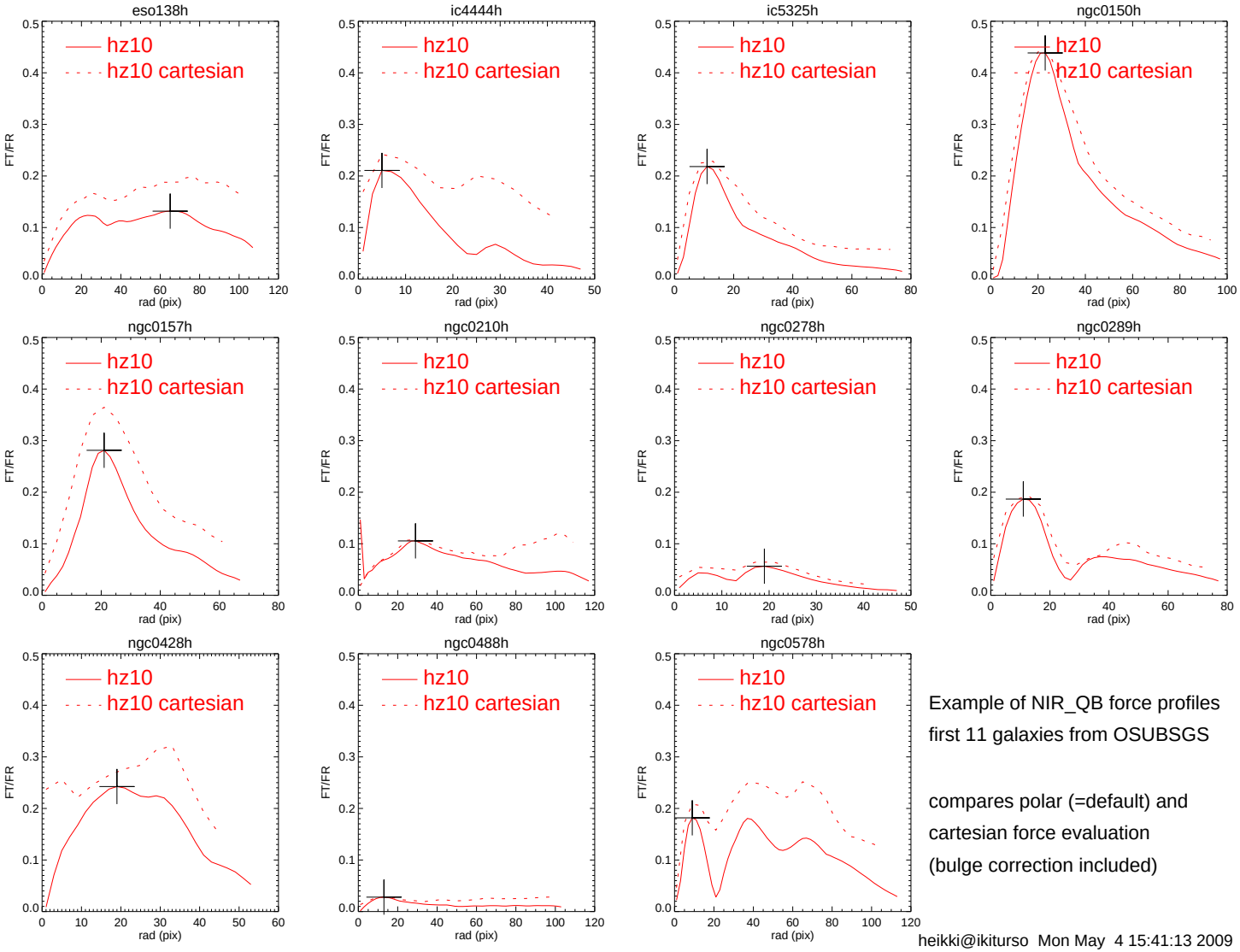
Noise supressed compared to Cartesian methods:

⇒ **applicable to weak outer structures**



Example of NIR_QB force profiles
first 11 galaxies from OSUBSGS

compares polar (=default) and
cartesian force evaluation
(bulge correction included)

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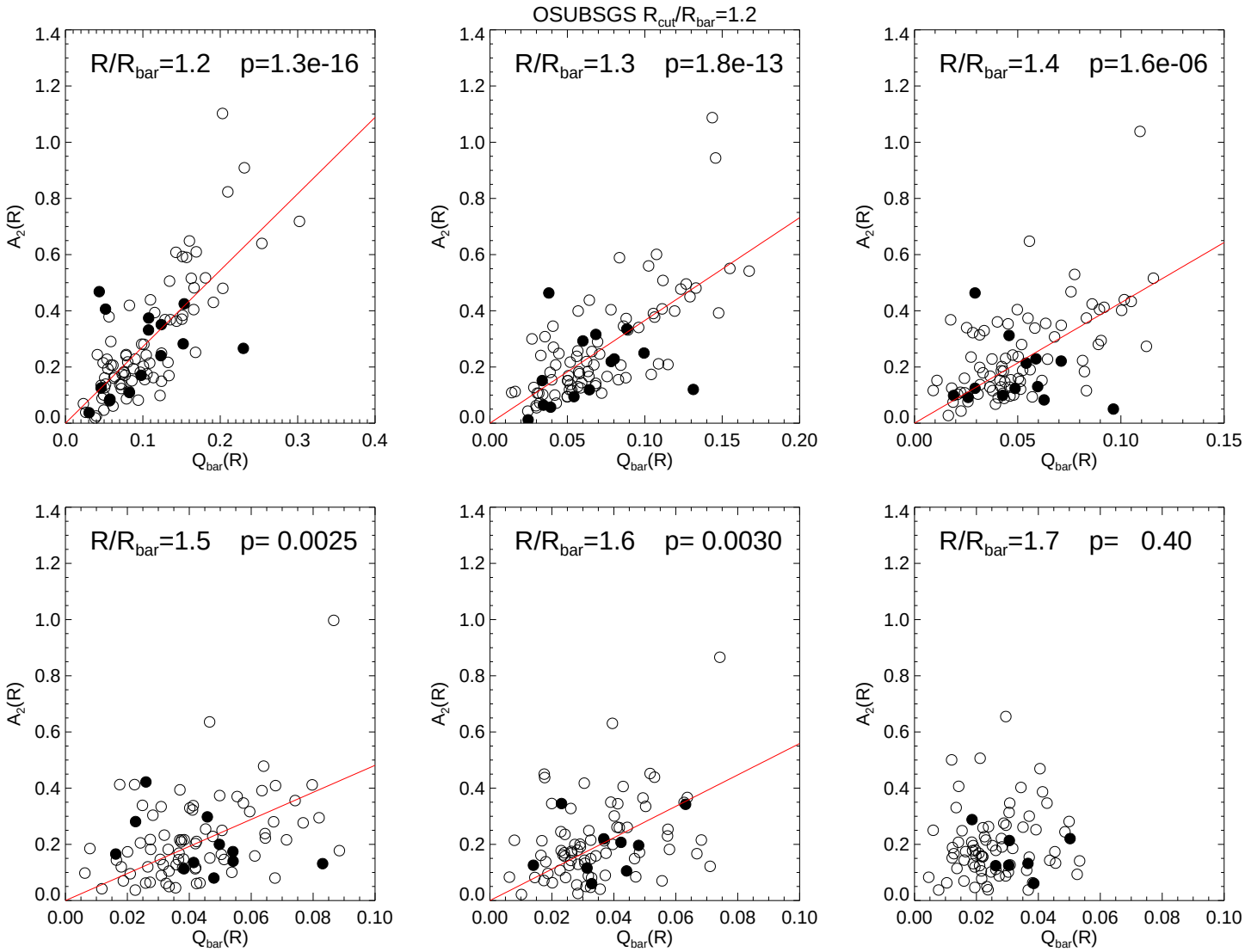
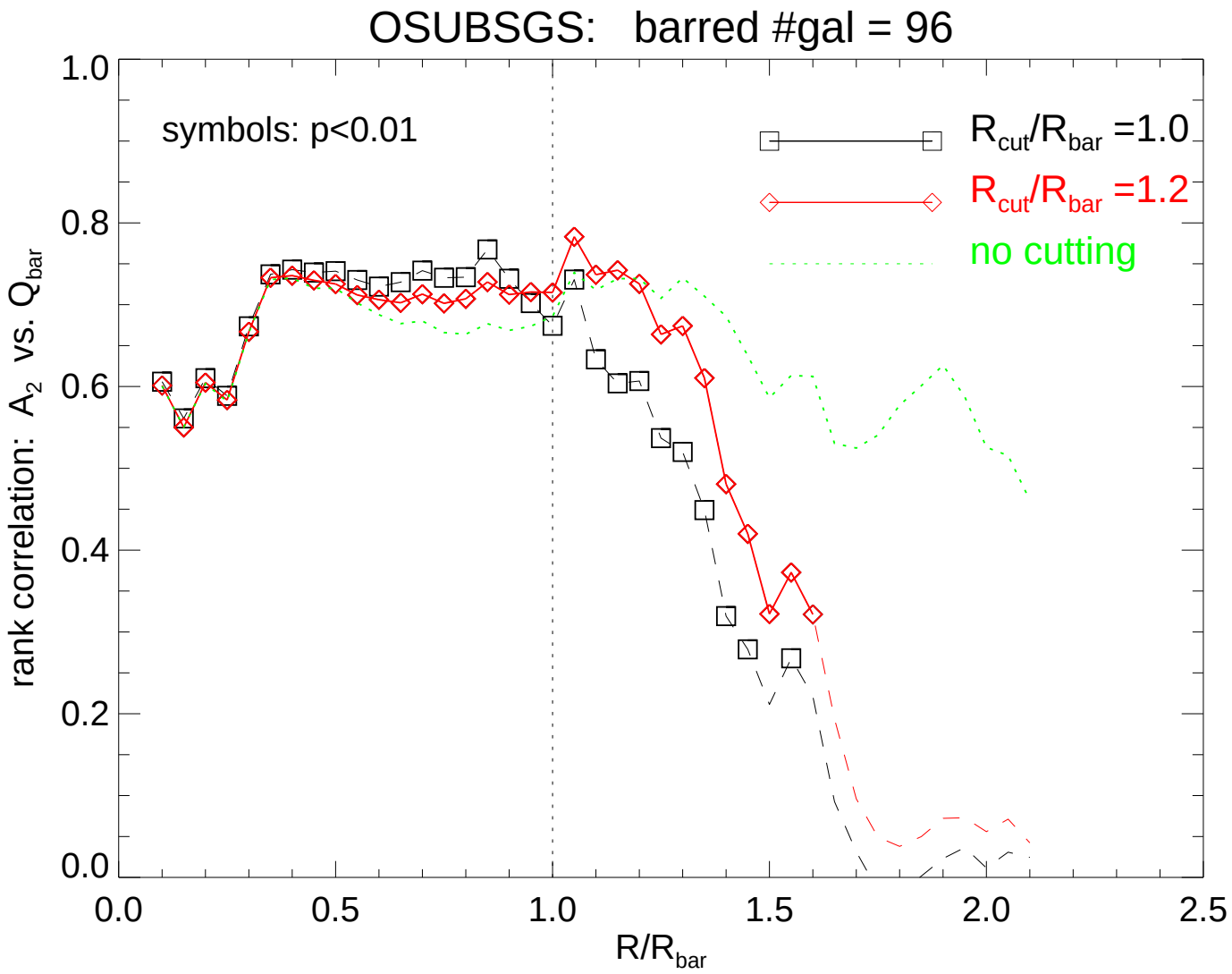
BAR-SPIRAL CONNECTION

Correlation of the local bar-induced FT/FR with the A_2 Fourier amplitude.



⇒ **Bar forcing vs. Spiral amplitude correlation**
statistically significant at least up to 1.5 bar radii (see the AAS poster)



SIMULATION ESTIMATES OF BAR PATTERN SPEEDS

- **Very simple sticky-particle models:**

  Rigidly rotating potential estimated from 3.6 micron images

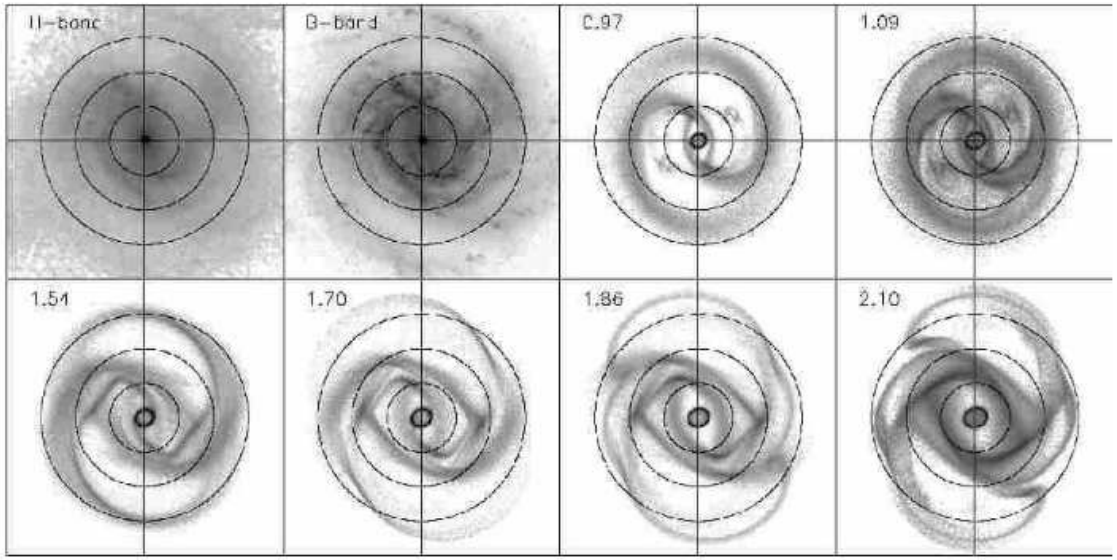
  - Vary the assumed pattern speed,

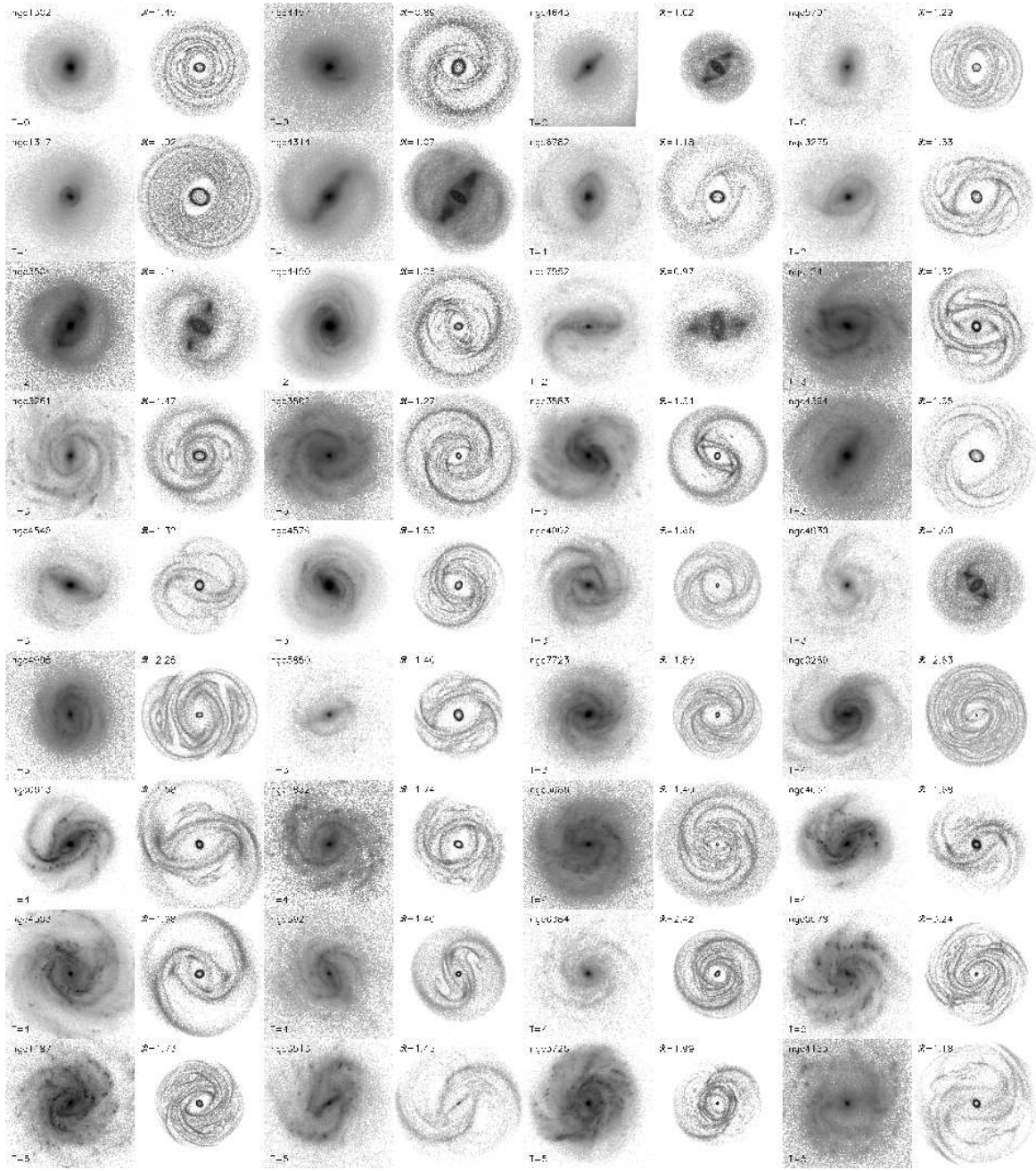
  - Vary the assumed amplitude of non-axisymmetric forces

  (allows for uncertainties in dark halo contibution, vertical profile etc...

  $\Rightarrow$ compare with morpholocigal features, kinematics if available $\Rightarrow$ Ω_{bar}

- **Not necessarily very accurate, but allows to study a large number of systems in a systematic fashion**



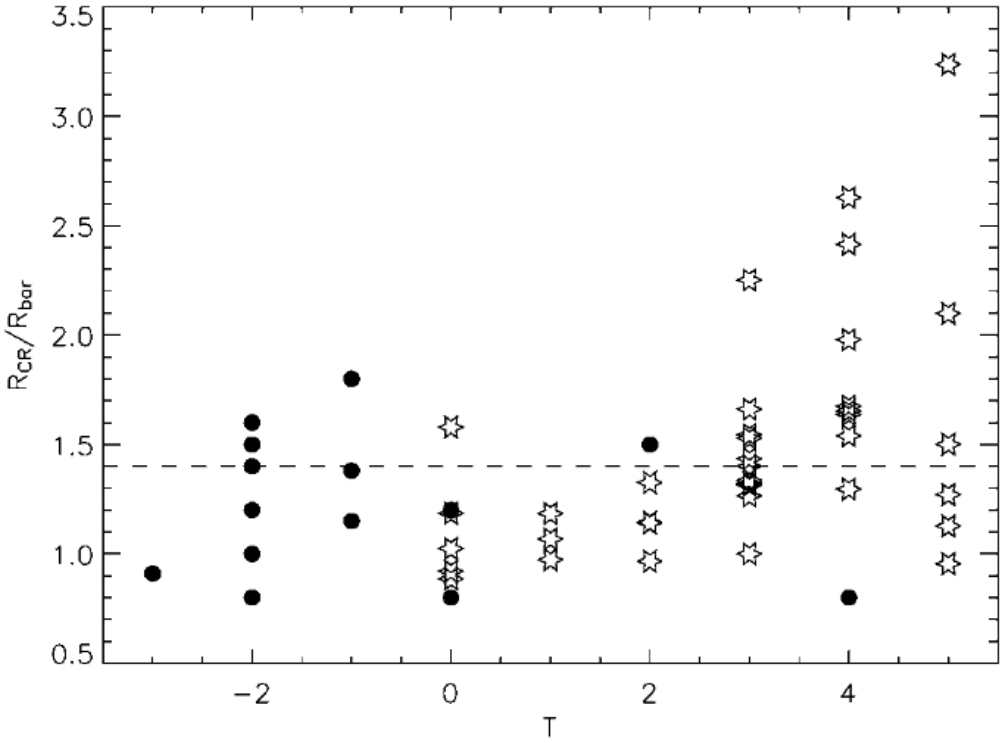


Models for OSUBSGS galaxies

Rautiainen, Salo, Laurikainen 2008

- **Pattern speeds as a function of morphological type**

  40 galaxies from OSUBSGS:



Rautiainen, Salo, Laurikainen 2008

NEAR-FUTURE GOALS:

Articles which can be based on the existing archive data
(later complemented with additional data when available)

- “Bars do drive spiral arms” (Heikki,...)

- “Scaling relations between the properties of bulges and disks” (Eija,...)

- Local bar forcing and ring properties (with Sebastien Comeron, Ron, Johan,...)