The black hole mass-bulge mass correlation

classical bulges vs. pseudobulges

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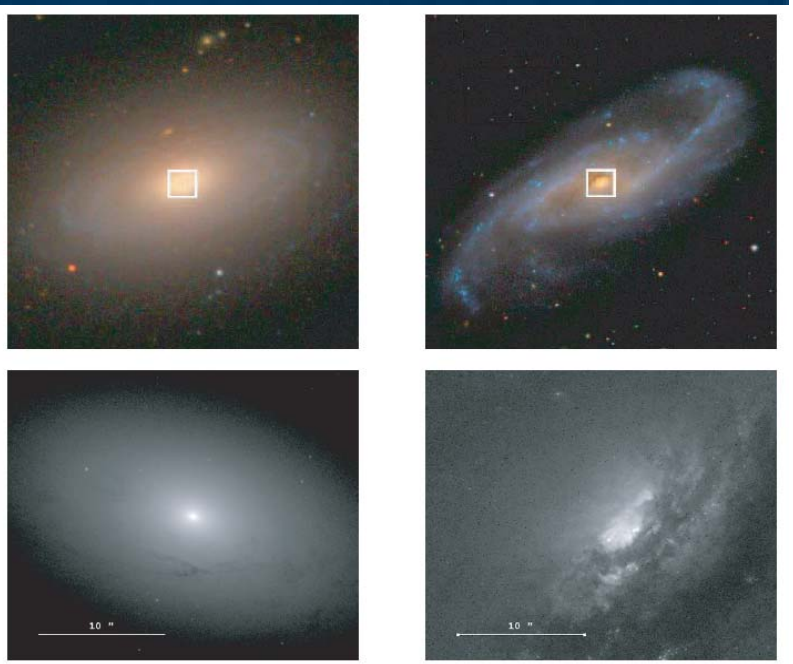
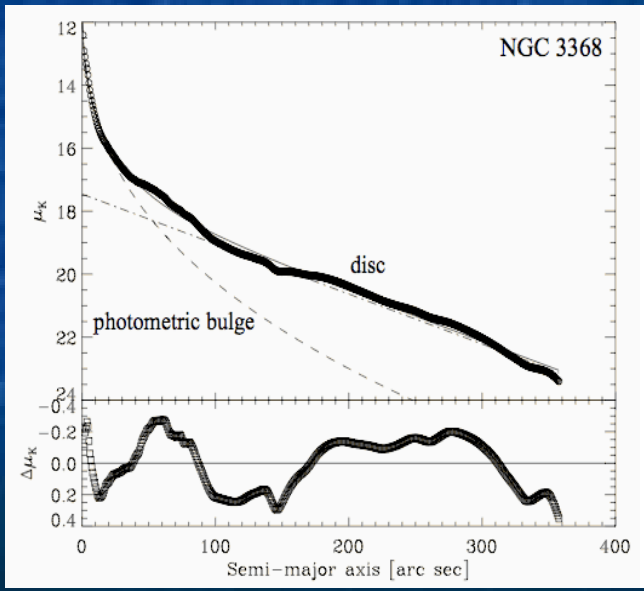
What are pseudobulges?

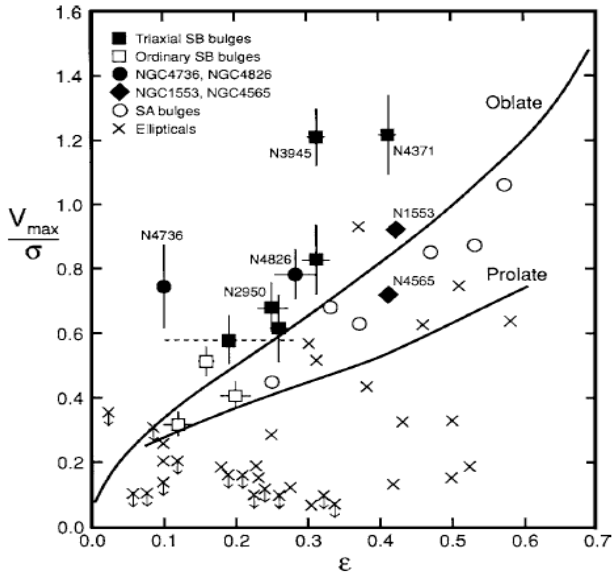
- Bulges: central spheroid components or extra mass/light over the disk
- Pseudobulges: Shape and kinematics disky (rotational), young stellar population, peculiar inner structures
- Formation: secular processes
- Identification: kinematics, photometry, morphology

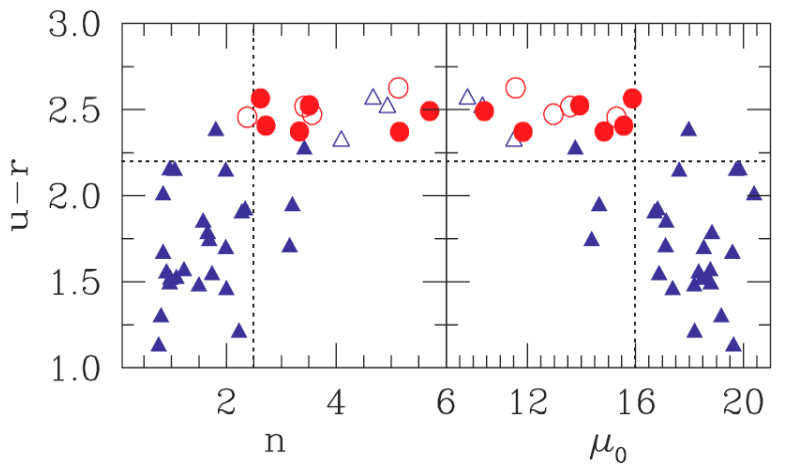
Cf. review of Kormendy & Kennicutt 2004, ARAA.

Classical bulge vs pseudobulge





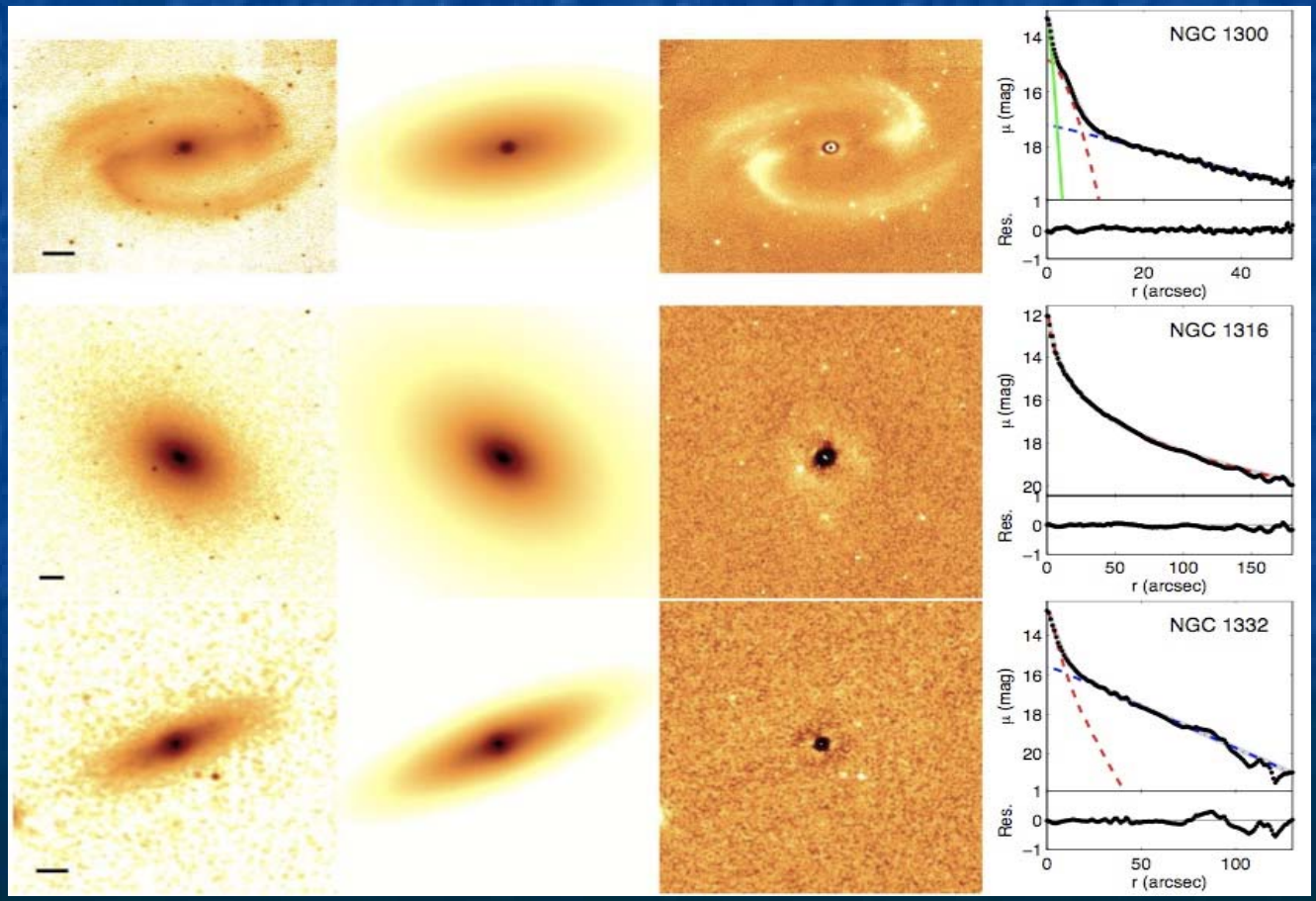




Nowak et al. 2010

Bulge properties measurement

- To measure bulge properties: 2-D galaxy decomposition
  - *BUDDA,* developed by D. Gadotti et al.
  - Disk: exponential profile; Bulge, bar: Sersic profile, central unresolved source: point+PSF
- K band image: smooth, relative small dust extinction
- Image: 2MASS, WHT, LCO archive data



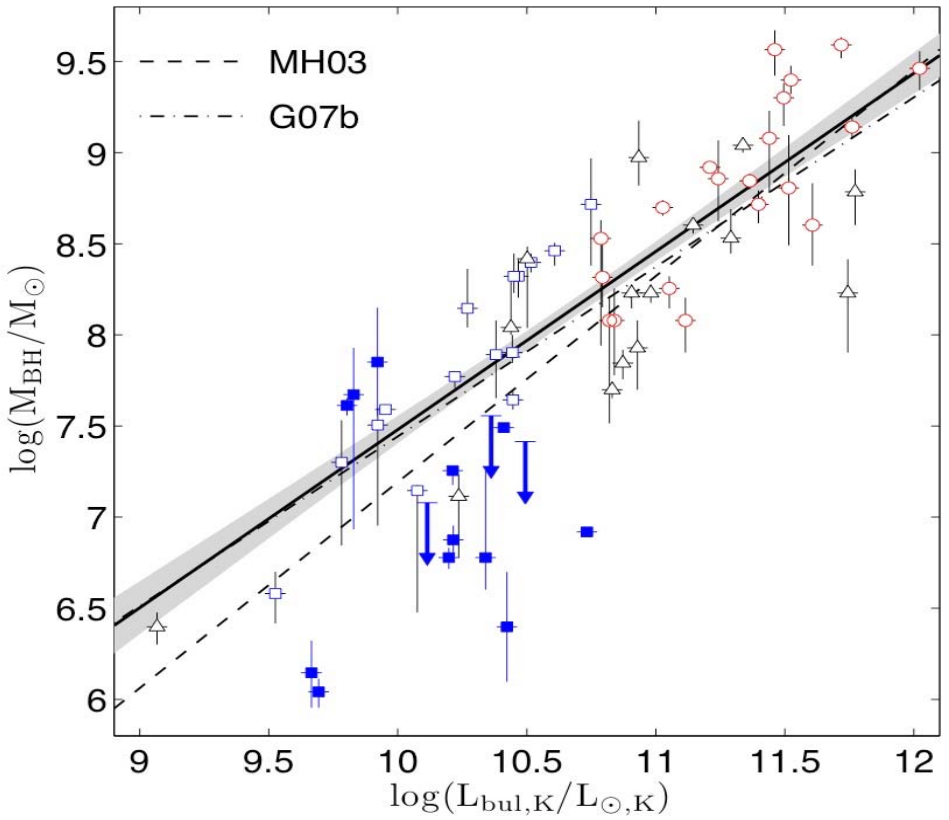
Pseudobulge

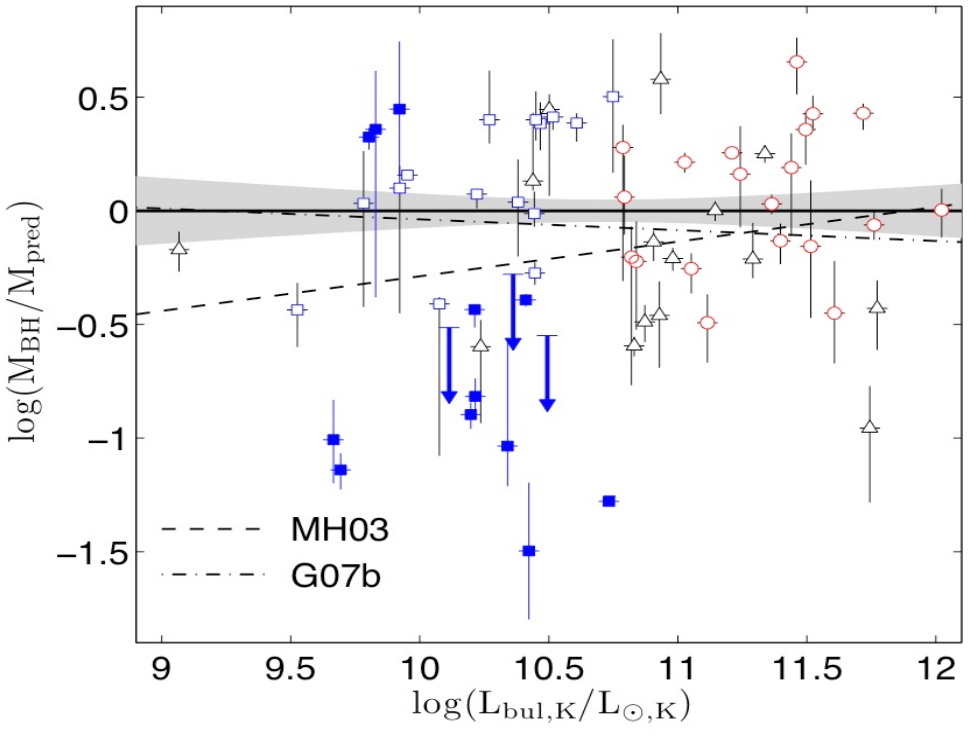
Elliptical galaxy

Classical bulge

M_{bh}- $L_{bul,\,K}$ relation revisited

- 50 elliptical galaxies/classical bulges+15 pseudobulges
- Slope (0.98±0.08) consistent with the previous results.
- Psuedobulges does not follow the M_{bh}-L relation of classical bulges;
  for given M_{bh}, L of pseudobulges may be much larger (>10 times).
- Core ellipticals follow the M_{bh}-L relation of classical bulges.



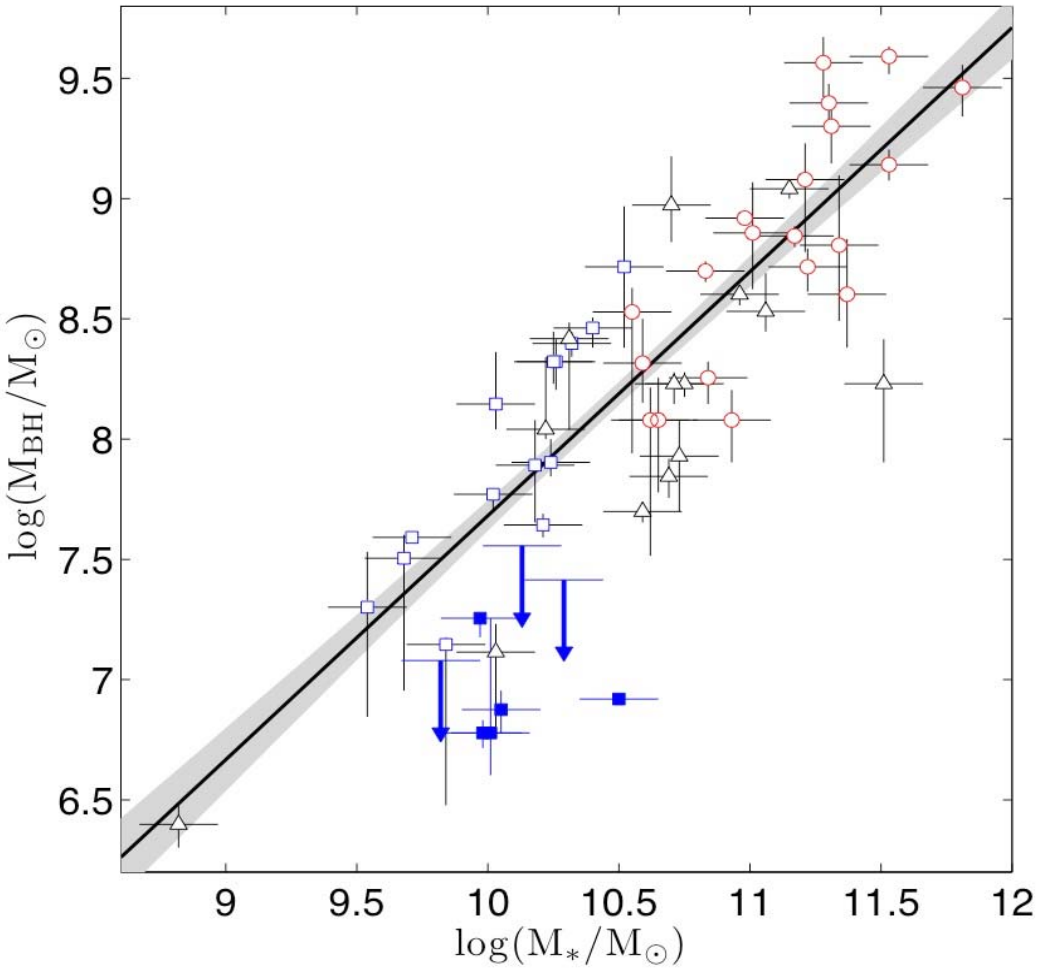


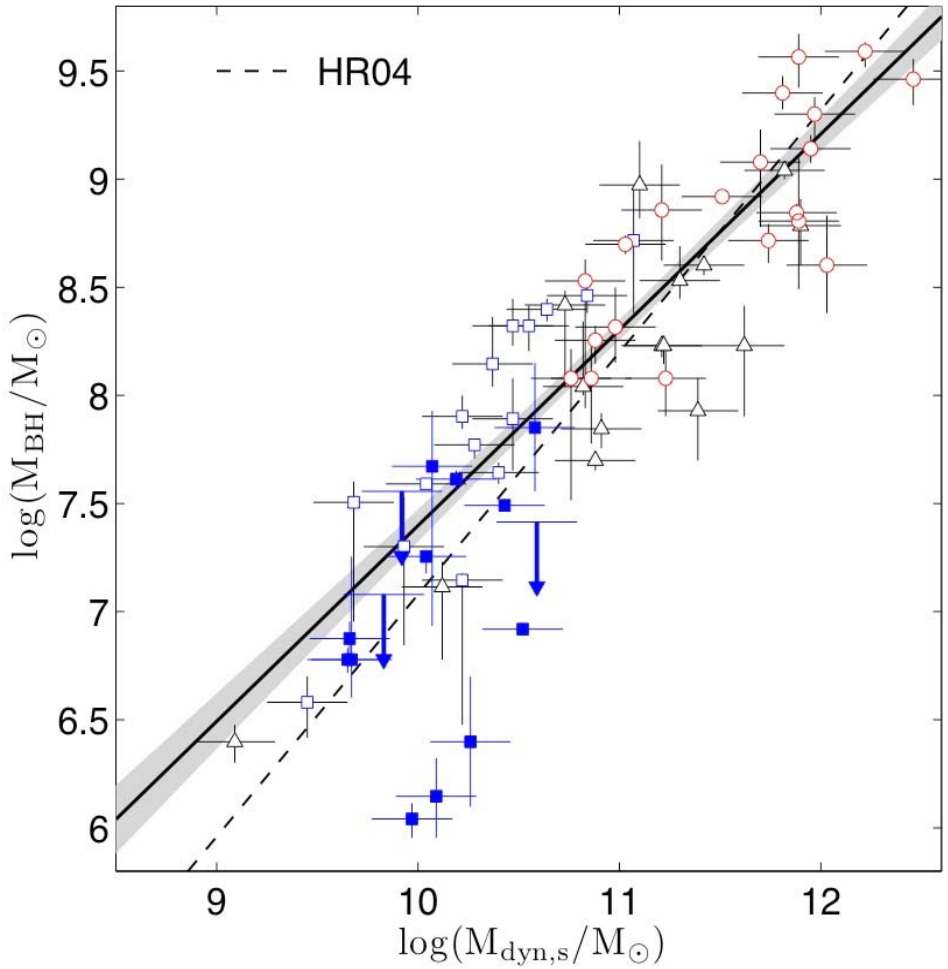
M_{bh}- M_* and M_{bh}- M_{dyn}

M*: M/L calibrated by Bell et al. 2003

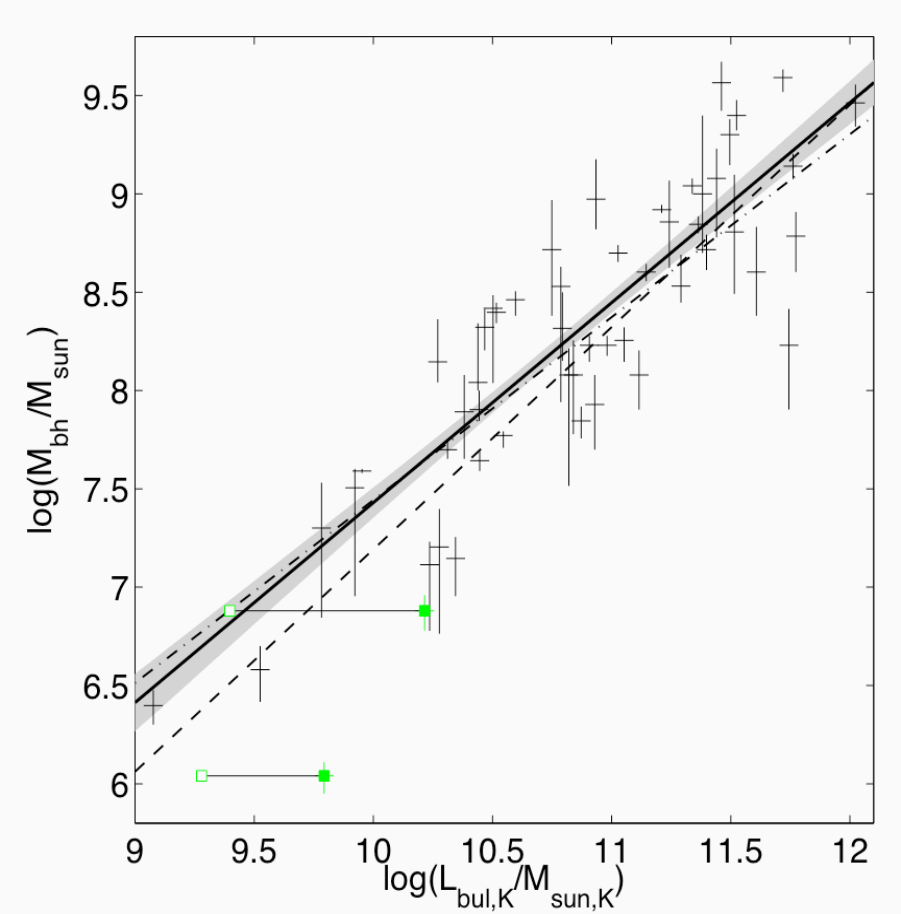
M_{dyn}: solve Jeans equation in Sersic mass profile

(For rotation supported pseudobulges, the Mdyn is only a lower limit)





- 20% S0 galaxies may have composite bulges.
- Classical bulges is ~5-25% as bright as the pseudobulges.
- Mbh seems to correlate with the embedded classical bulges better.



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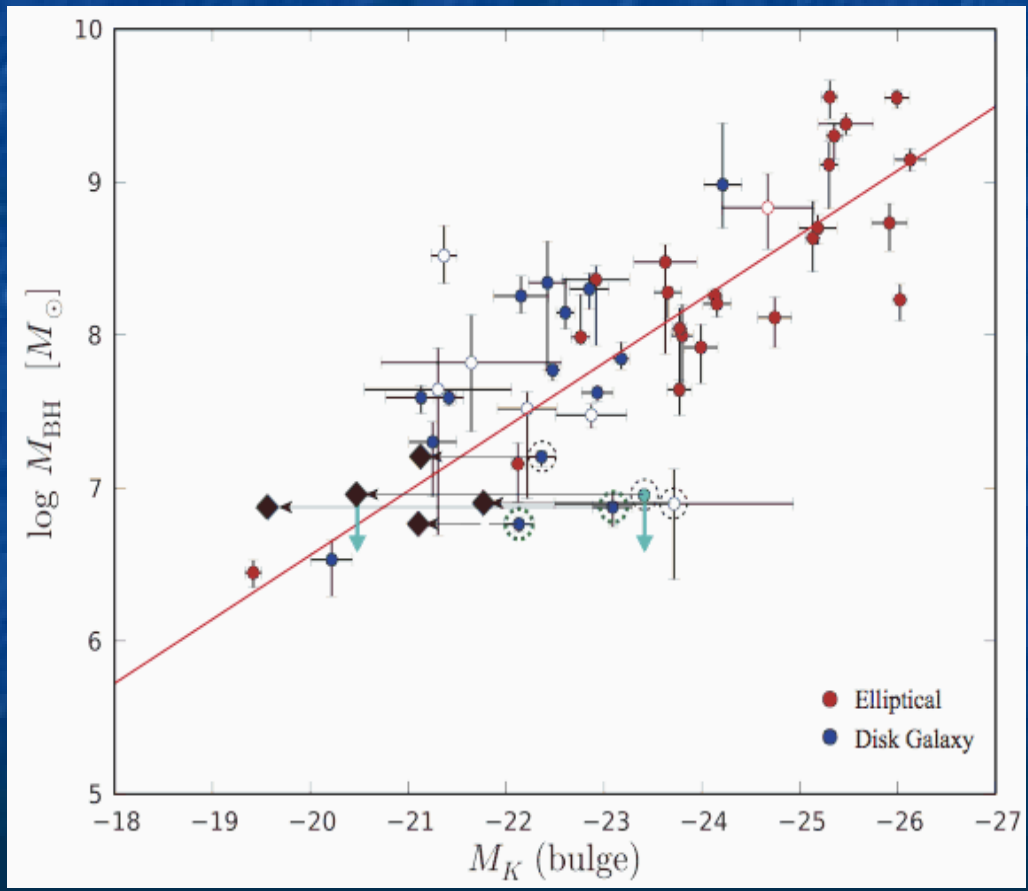

- (Erwin & Gadotti 2010)

Summary

- Observation:
  - Pseudobulges don't obey the M_{bh}-L_{bul} relation of classical bulges.
  - Core elliptical galaxies and classical bulges have similar M_{bh}-L_{bul} relations.
  - Mbh only correlated with the mass of classical bulges.
- Explanation:
  - M_{bh}-L_{bul} relation for classical bulges are products of self regulation (BH feedback on bulges) after major mergers or other violent processes.
  - BH feedback does not work effectively on pseudobulges.