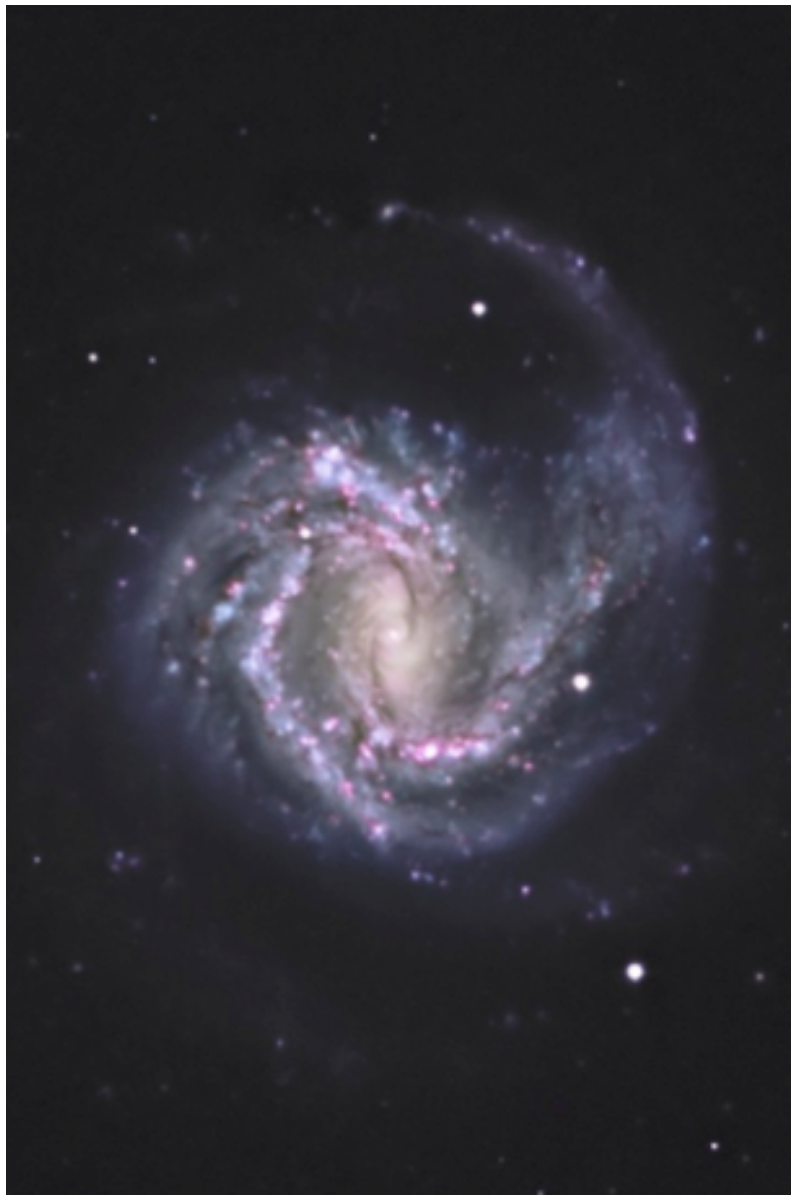
The role of bars in AGN fuelling in the last seven billion years

Johan Knapen (IAC)
Mauricio Cisternas (ex-IAC)

Stellar bars

- Very common: 2/3 of local disk galaxies
- Fewer at higher *z*
- Re-distribute angular momentum (outwards)
- Allow inflow of gaseous material (inwards)



Effects of gas inflow

- Clear links between bars and increased (circum)nuclear star formation
- Inflow can slow down near Inner Lindblad Resonances and form stars in a nuclear ring
- But can bar-driven inflow reach the inner region, and fuel an AGN?
  - Possible complications: time- and spatial scales different
  - Advantage: bars common and we know they drive inflow (and “bars within bars” can theoretically fuel AGN)

Bars and Seyferts

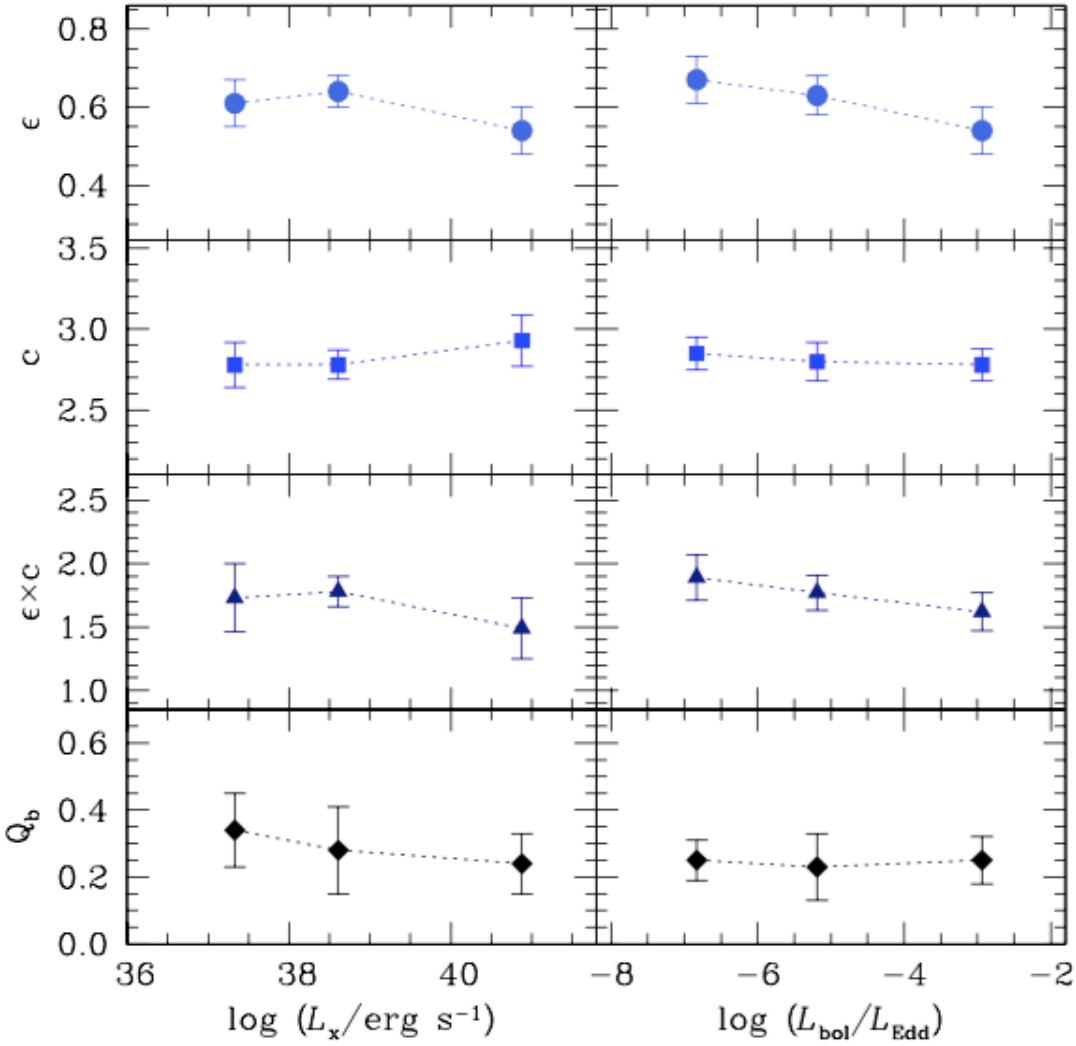
- Some statistical links established, but effects are not large
- For instance, we found that 80% of Seyfert hosts are barred, vs 60% of a non-AGN control sample (2σ effect; Knapen et al. 2000)
- Small bars do not show a larger effect (*HST* study, including nuclear bars; Laine et al. 2002)

Bar strength

- Do stronger bars result in more AGN fuelling?
- We studied 41 galaxies with Chandra imaging which have good analysis of bar parameters from mid-IR imaging in the *Spitzer* S^{4}G survey
- Determine presence and parameters of the AGN from X-ray morphology and flux
- Cisternas et al. 2013, ApJ 776, 50

Bar strength does not influence AGN

- Two AGN activity measures: *Left* X-ray luminosity and *Right* Eddington ratio
- Top to bottom: four different measures of bar strength
- Points: median values per AGN activity bin
- Conclusion: no correlation

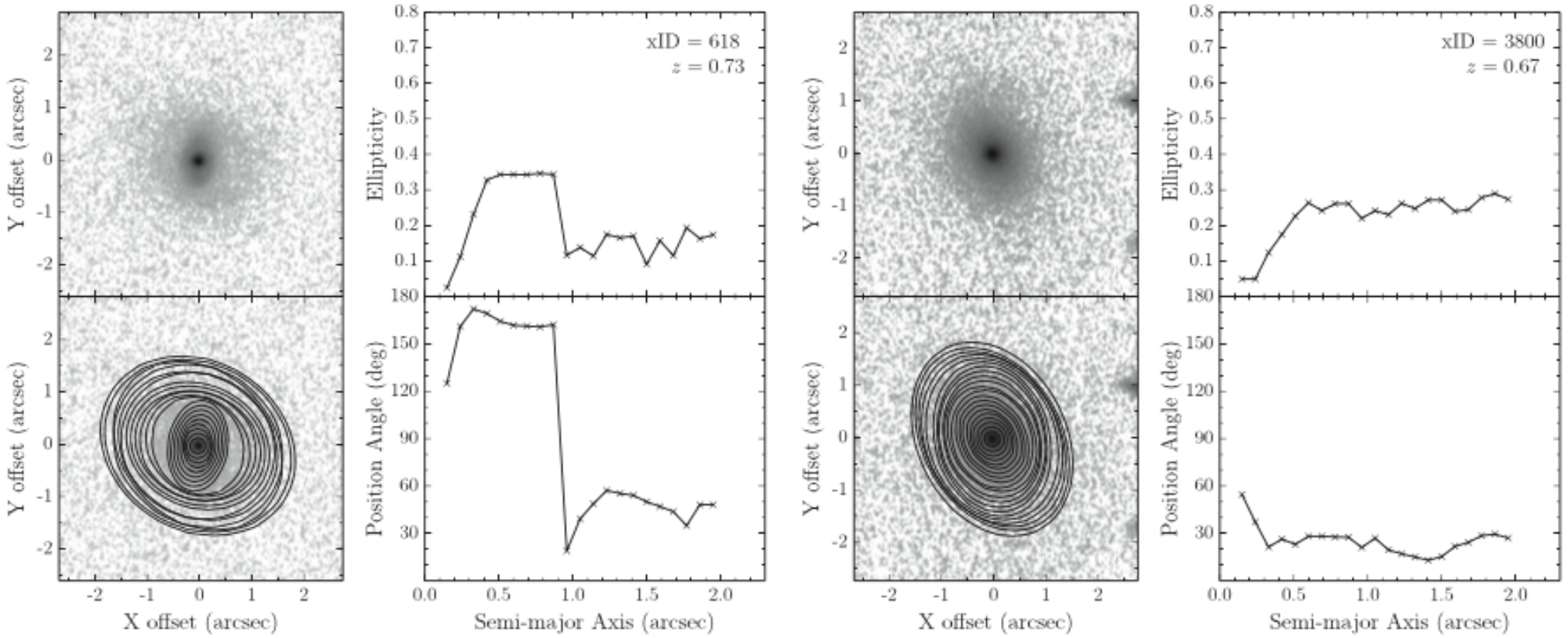


Bar strength-AGN

- 31 of 41 X-ray-imaged galaxies have evidence for low-luminosity AGN activity
- No significant correlation between bar strength and level of AGN activity
- Mechanisms responsible for low-*L* AGN fuelling cannot be traced on scales larger than a few hundred parsec
- Other sources supply fuelling to AGN
  - (In any case, a bar would supply much more fuel than needed for low-*L* AGN)

Redshift effects

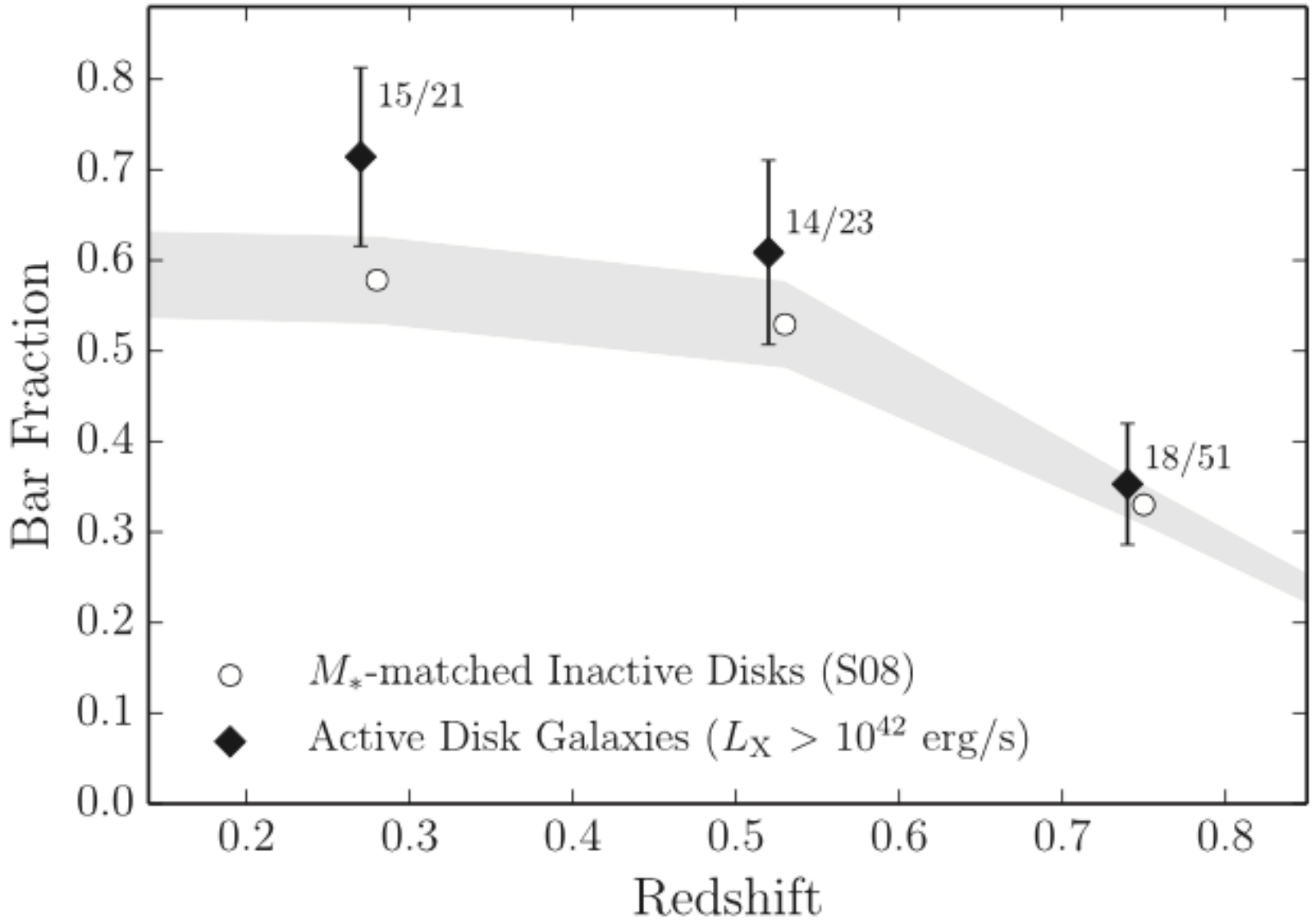
- Do bars have more effect on AGN at higher redshifts?
- Studied AGN in the Chandra COSMOS field:
  - 95 AGN at $0.15 < z < 0.835$ in face-on or moderately inclined L^* disk galaxies
- Identify bars visually and through ellipse fitting
  - 47 of the 95 galaxies are barred
- Cisternas et al. 2015, ApJ 802, 137



Ellipse fitting results on *HST*/ACS F814W images

Barred active galaxy
z=0.73

Unbarred active galaxy
z=0.67



- Bar fraction as function of redshift for active (filled symbols) and non-active galaxies (open circles and grey band).
- *Mass-matched* control sample (important because AGN live in more massive hosts)

AGN bar fraction with redshift

- Studied 95 AGN in Chandra/COSMOS field, and a mass-matched control sample
- Bar fraction decreases from 71±10% at z~0.3 to 35±7% at z~0.8, similar to non-active galaxies
- AGN host bar fraction enhanced at low redshifts, but compatible with no enhancement at higher z
- AGN activity appears largely independent of large-scale structure of host
- At higher redshifts, by far most AGN hosts are not barred so bar can never be a dominant driver for activity

Conclusions

- Bars can redistribute angular momentum, and can drive gas inflow
- Evidence for slight increase in bar fraction among AGN hosts when compared to non-AGN
- No significant correlation between bar strength and level of AGN activity
- No evidence for higher AGN host bar fraction at higher redshifts
- Role of bars in fuelling AGN is limited