Variations in the 24 μm Morphologies of Nearby Galaxies

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Scientific Motivation

- The connection between morphological type and either ***integrated*** ISM content or star formation activity has been firmly established, but it is unclear whether the ***distribution*** of either the ISM or star formation varies along the Hubble sequence.
- Variations in the distribution of the ISM or star formation between early- and late-type spirals could reveal differences in their evolution and could help explain the connection between star formation and the bulge/disk ratio.

Previous Results

- Groups identifying variations in distribution of star formation/ISM along Hubble sequence:
    - Hodge & Kennicutt (1983) — Hα
    - Young et al. (1995) — CO
    - Bendo et al. (2002) — 12, 60 μm
    - Thomas et al. (2004) — 850 μm
    - Pahre et al. (2004) — 8 μm
- Groups not identifying variations:
    - Dale et al. (2001) — Hα
    - Thomas et al. (2004) — HI
    - Koopmann et al. (2006) — Hα
- Problems with these previous surveys
    - Extinction at optical wavelengths
    - Limited sample size
    - Limited spatial coverage
    - Lack of quantitative analysis

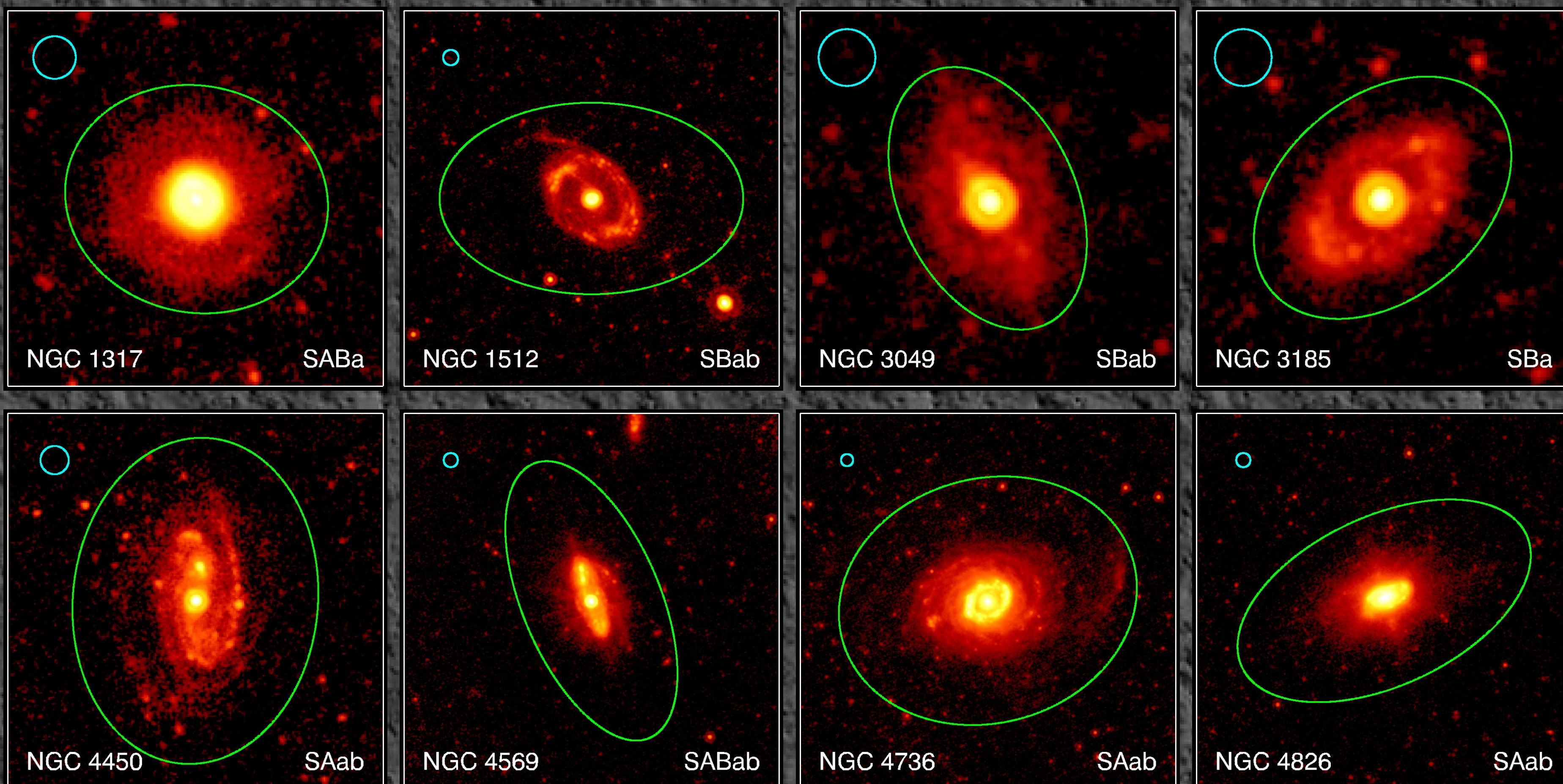
Goals of This Project

- In the 24 μm images from SINGS, measure five parameters that describe the morphology of the emission.
  - ❖24 μm emission is a tracer of dust heated by star formation regions and, to some degree, the dust itself.
- Determine whether these morphological parameters vary as a function of Hubble type.

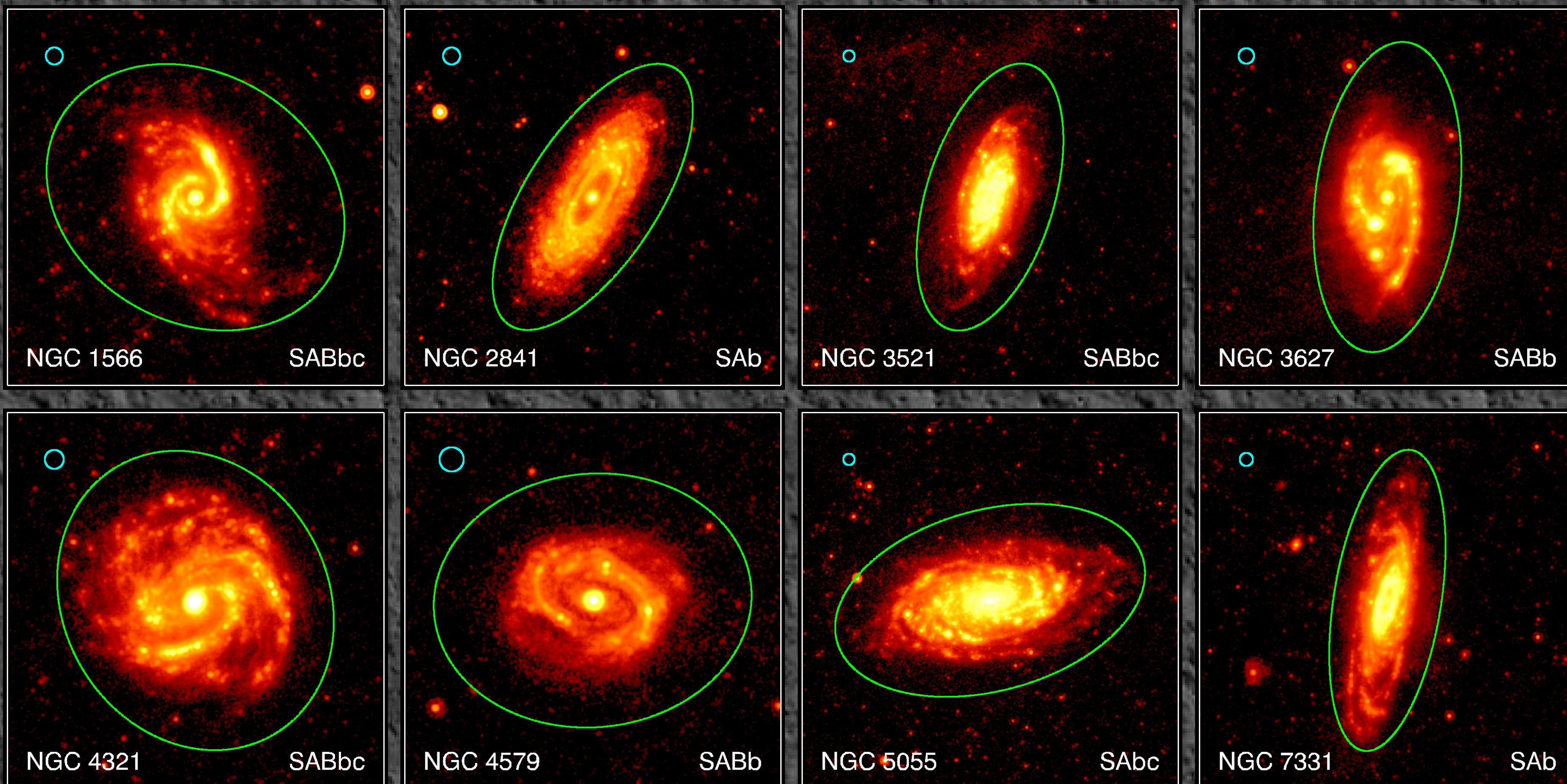
Morphological Parameters

- **C** – Concentration parameter
- $\mathbf{\bar{M}_{20}}$ – Alternate concentration parameter
- **Log ($\mathbf{\bar{R}_{eff}}$)** – Central concentration of the infrared light relative to the optical light
  - $\mathbf{\bar{R}_{eff} = R_{IR}(50\%)/R_{optical}}$
- **A** – Asymmetry parameter
- **G** – Gini coefficient (measure of uniformity)

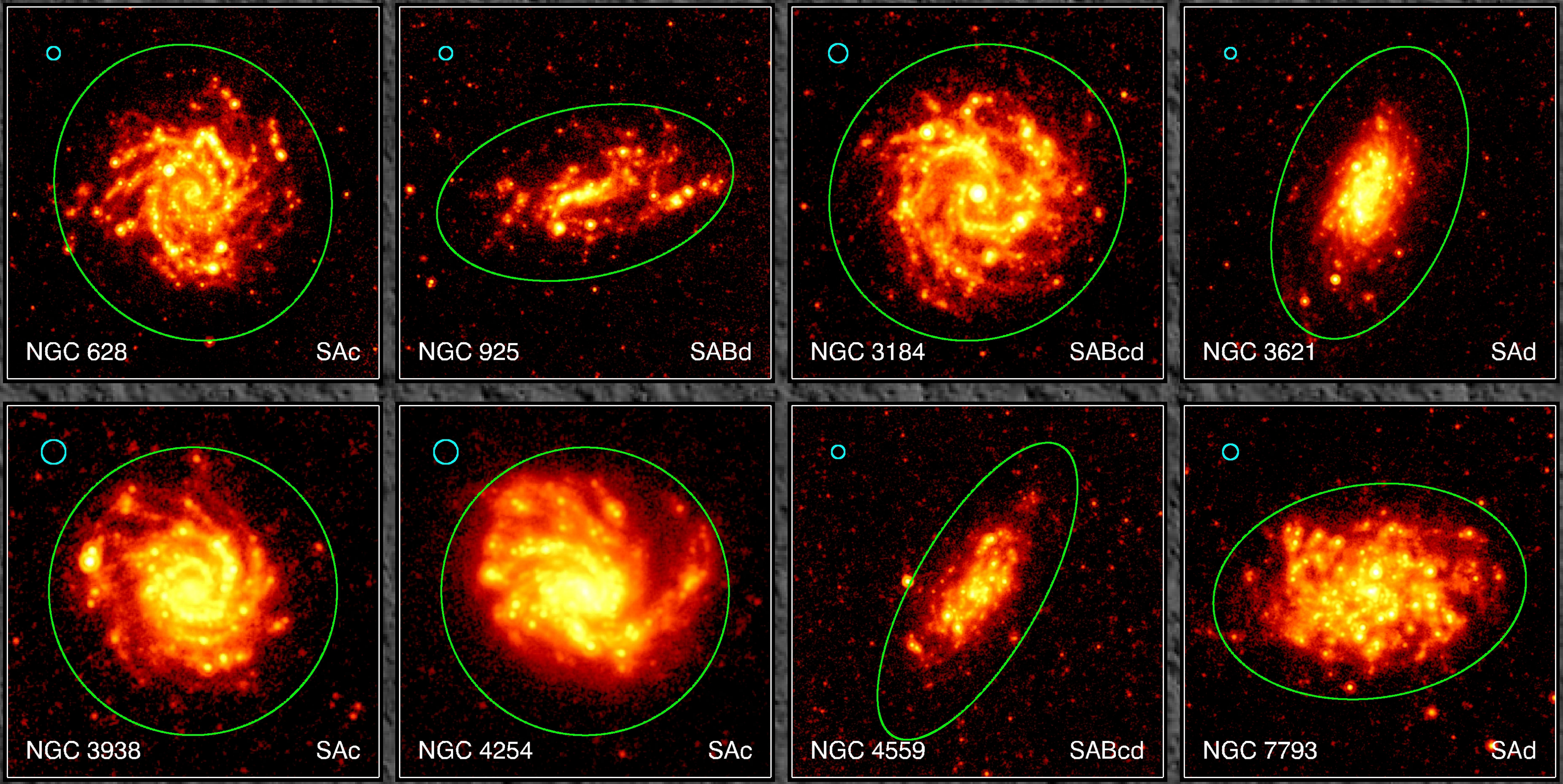
S0/a-Sab Galaxies



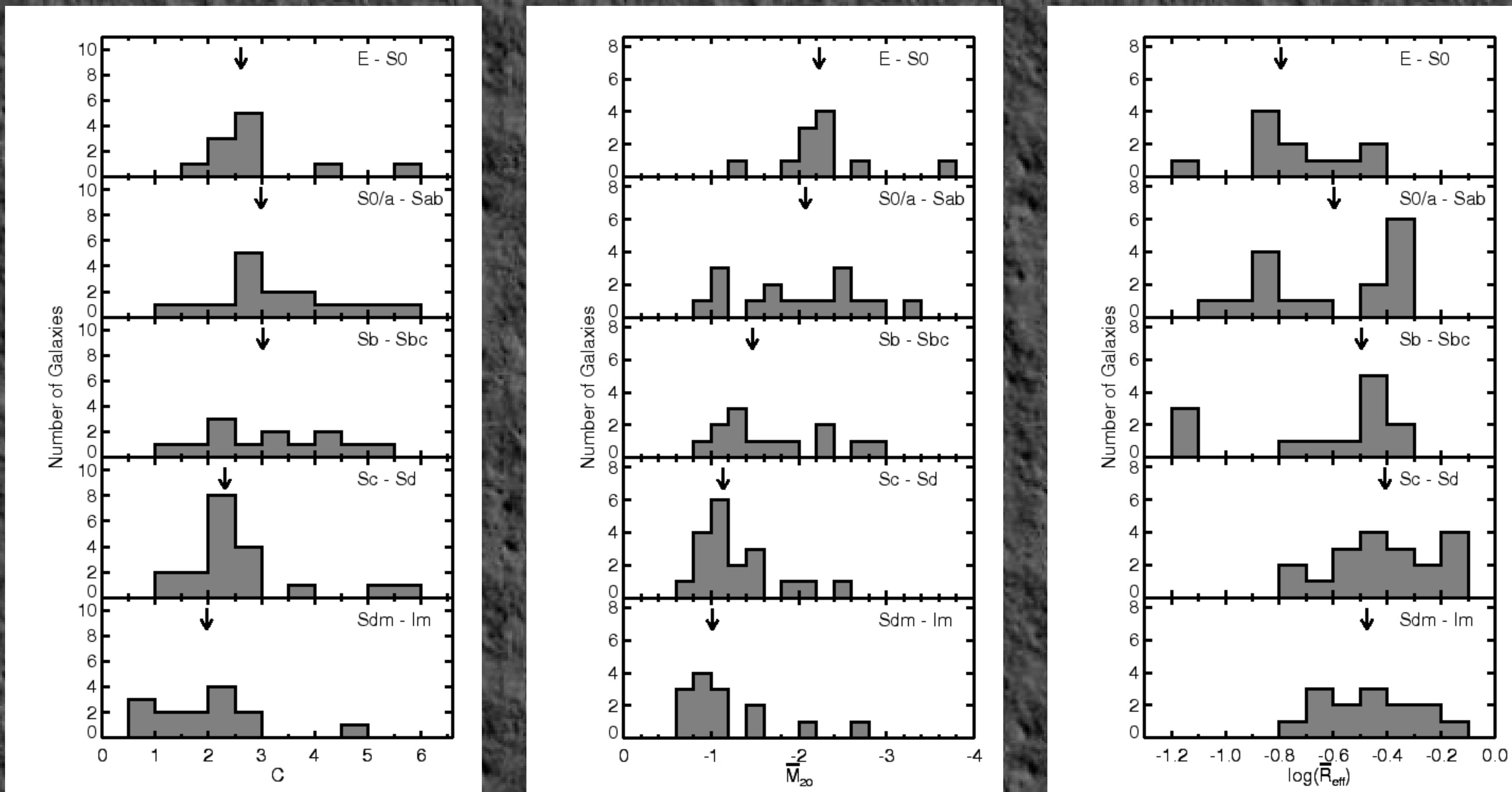
Sb-Sbc Galaxies



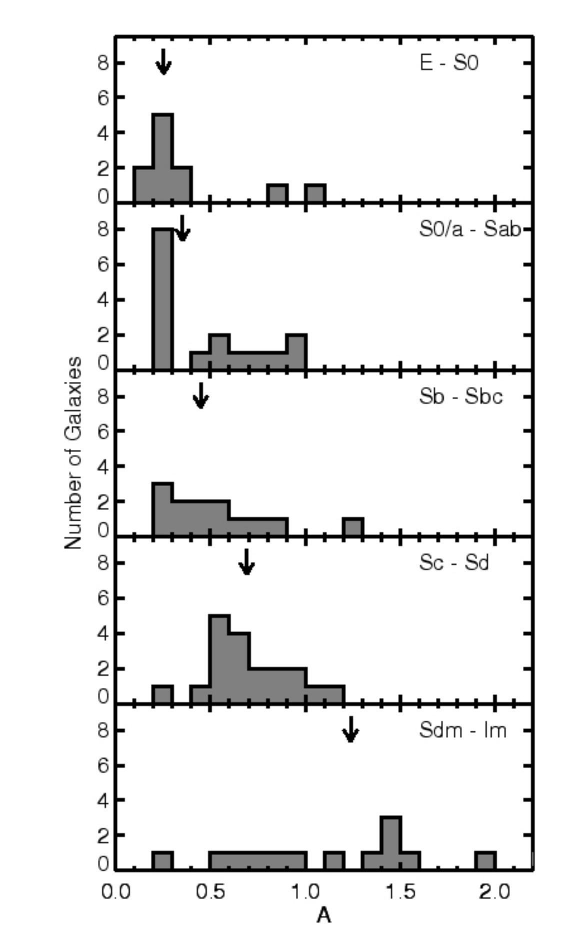
Sc-Sd Galaxies

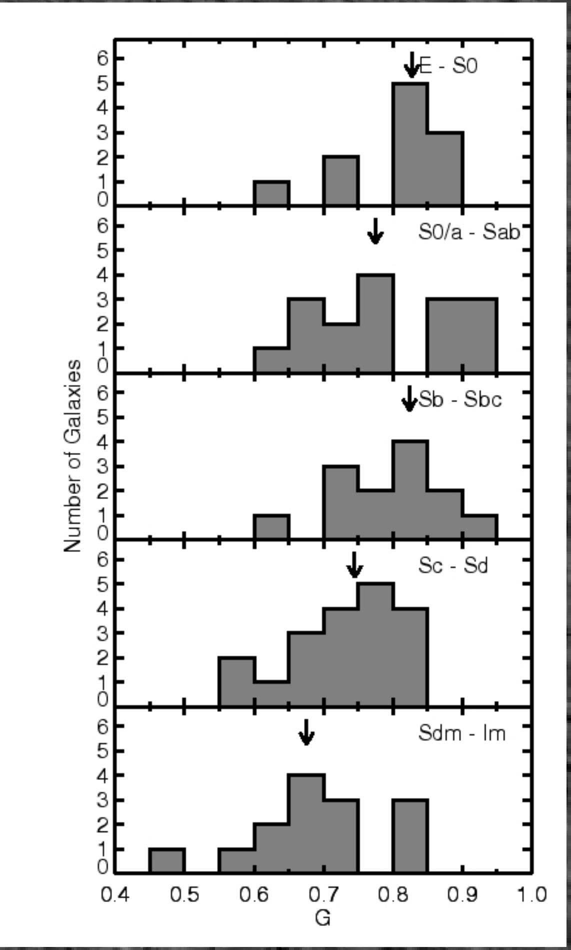


Morphological Parameters versus Hubble Type



Morphological Parameters versus Hubble Type



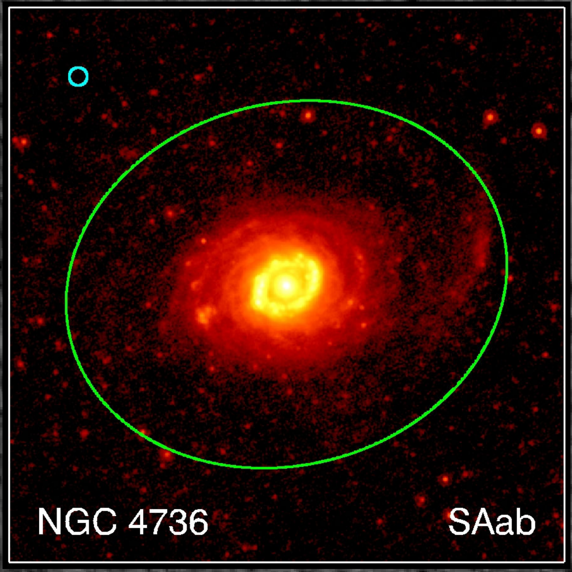


Connection between Distribution of 24 μm Emission and Morphology

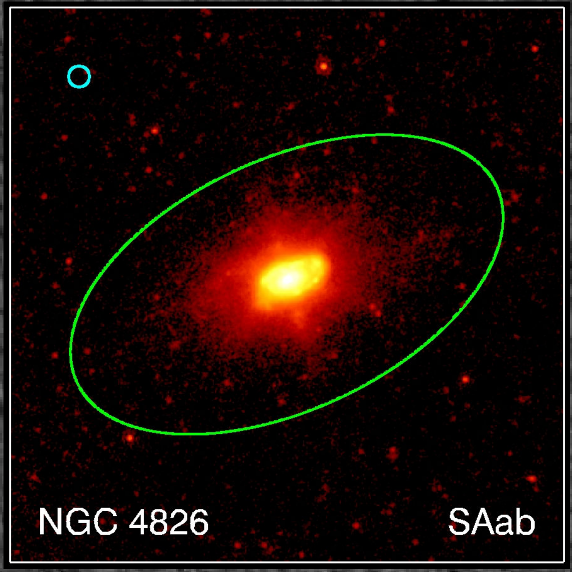
Multiple mechanisms could both change the real/apparent bulge/disk ratios and the distribution of dust emission within early-type spiral galaxies.

- Pseudobulge formation mechanisms could drive the ISM into the centers of spiral galaxies.
- Inequal-mass mergers could build large central bulges and cause the ISM to fall into the centers of galaxies.
- Ram-pressure stripping in clusters could remove the ISM from the outer disks of spiral galaxies, leading to conditions where, over time, the disk will fade compared to the bulge.

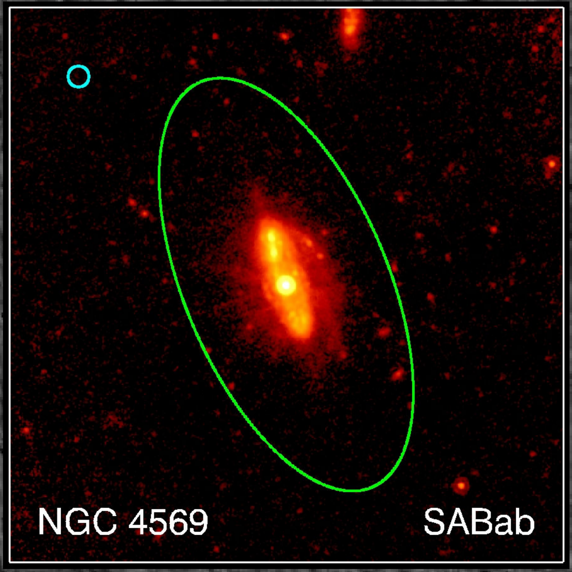
Example S0/a-Sab Galaxies



Pseudobulge

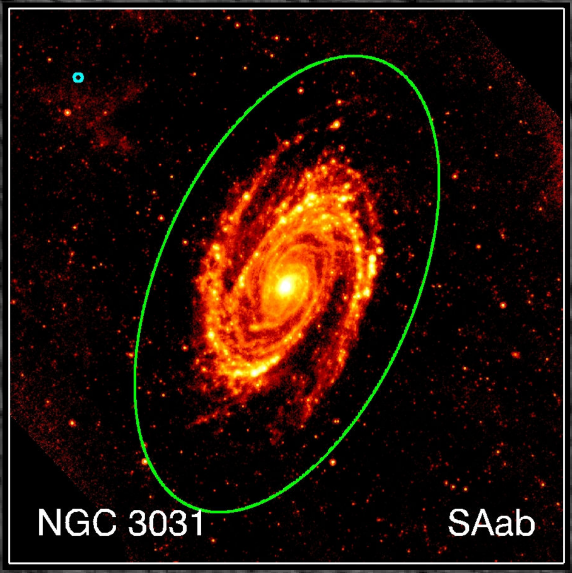


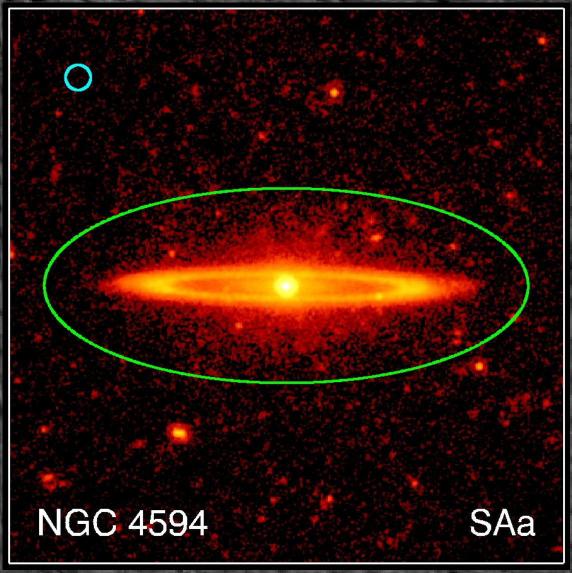
Inequal-Mass Merger

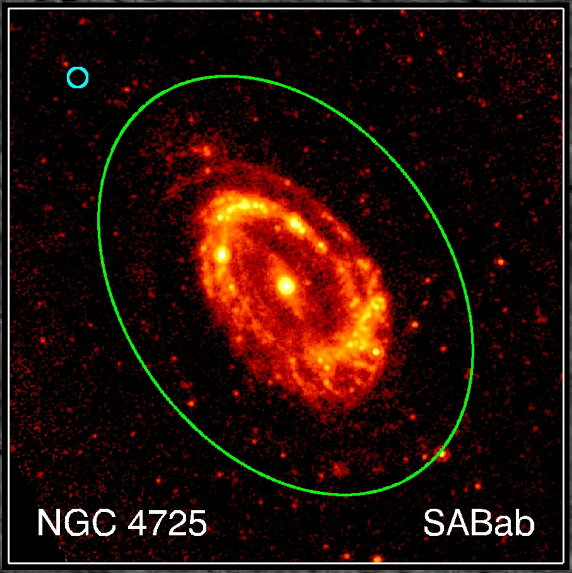


Ram-Pressure Stripping

Atypical S0/a-Sab Galaxies







Conclusions

- S0/a-Sab galaxies appear to be compact, symmetric 24 μm sources, while Sc-Sd galaxies appear to be extended, asymmetric sources.

- Pseudobulge formation mechanisms, mergers, and ram-pressure stripping could all affect both the distribution of the ISM and the real/apparent size of the bulges in these galaxies. Nonetheless, all of these mechanisms produce galaxies that appear similar at 24 μm.