1. Introduction

- Early-type galaxies (ETGs): elliptical (E) / lenticular (S0) galaxies
  - filled with hot X-ray plasma (destructive of dust)
  - dominated by old stars (less productive of dust)
  - However recent observations detect observable amounts of dust & PAHs from many ETGs, yet their supply channels are not well understood.

We perform a systematic study of dust and star formation for a large sample of ETGs.

2. Sample & data

- Sample: ATLAS$^{3D}$ 260 ETGs ($M_*>21.5$, Dc=2 Mpc; Cappellari+11)
  - Kinematic classification (Emsellem+11)
  - stellar velocity maps
  - Fast rotator (224/260)
    - regular velocity field, $\approx$S0
  - Slow rotator (36/260)
    - complex velocity field, $\approx$E

- Data
  - AKARI all-sky surveys: 9, 18, 65, 90 & 140 $\mu$m bands
  - New dust measurements for the ATLAS$^{3D}$ ETGs (Kokusho+17)
  - 2MASS & WISE catalog: K, 3.6, 4.2, 12 & 22 $\mu$m bands
  - Literature measurements of the cold (CO & HI) & X-ray gas phases

3. Results & Discussion

- Dust emission
  - Aperture photometry
  - SED fitting
    - star: power law
      - PAH: Draine+07 model
      - warm & cold dust:
        - Draine&Li $\propto B^4(T)$
        - $M_{\text{dust}}=\frac{F_{\nu}D^2}{\kappa_{\nu}B(\nu)}$
        - $\kappa_{\nu}B(\nu) = 0$ (140 $\mu$m; Draine 00)
        - $M_{\text{dust}}(=M_{\text{warm}}+M_{\text{cold}})$, $L_{\text{90H}}$

- Dust & stellar masses
  - No correlation b/w $M_{\text{dust}}$ & $M_*$
  - Some ETGs are well above the expected $M_{\text{dust}}$

- Dust & cold gas
  - (CO & HI measurements for 260 & 166 ETGs, respectively: Young+11, Serra+12, Young+14)
  - $M_{\text{dust}}$ vs. $M_{\text{gas}}$ (central HI $\approx$34'x45')
  - $M_{\text{dust}}$ vs. $M_{\text{gas}}$ (global HI)

- Correlation b/w $M_{\text{dust}}$ & $M_{\text{gas}}$
  - like late-type galaxies
  - dense ISM of ETGs has $M_{\text{dust}}/M_{\text{gas}}$ similar to late-type galaxies
  - Inclusion of outer HI weakens the correlation
  - poor diffuse HI envelope?

4. Conclusion

- Dust and PAH emission are detected from many ETGs, that may have acquired the cold ISM through external paths.
- Fast rotators show correlation between dust and X-rays, which appears to be caused by their higher current star formation activities than slow rotators.
- Fast rotators follow the KS law of late-type galaxies, suggesting that their star formation may not be suppressed.