New cooling curve due to the updates of collisional excitation in the plasma code SPEX

The impact on photoionisation and cooling flow models

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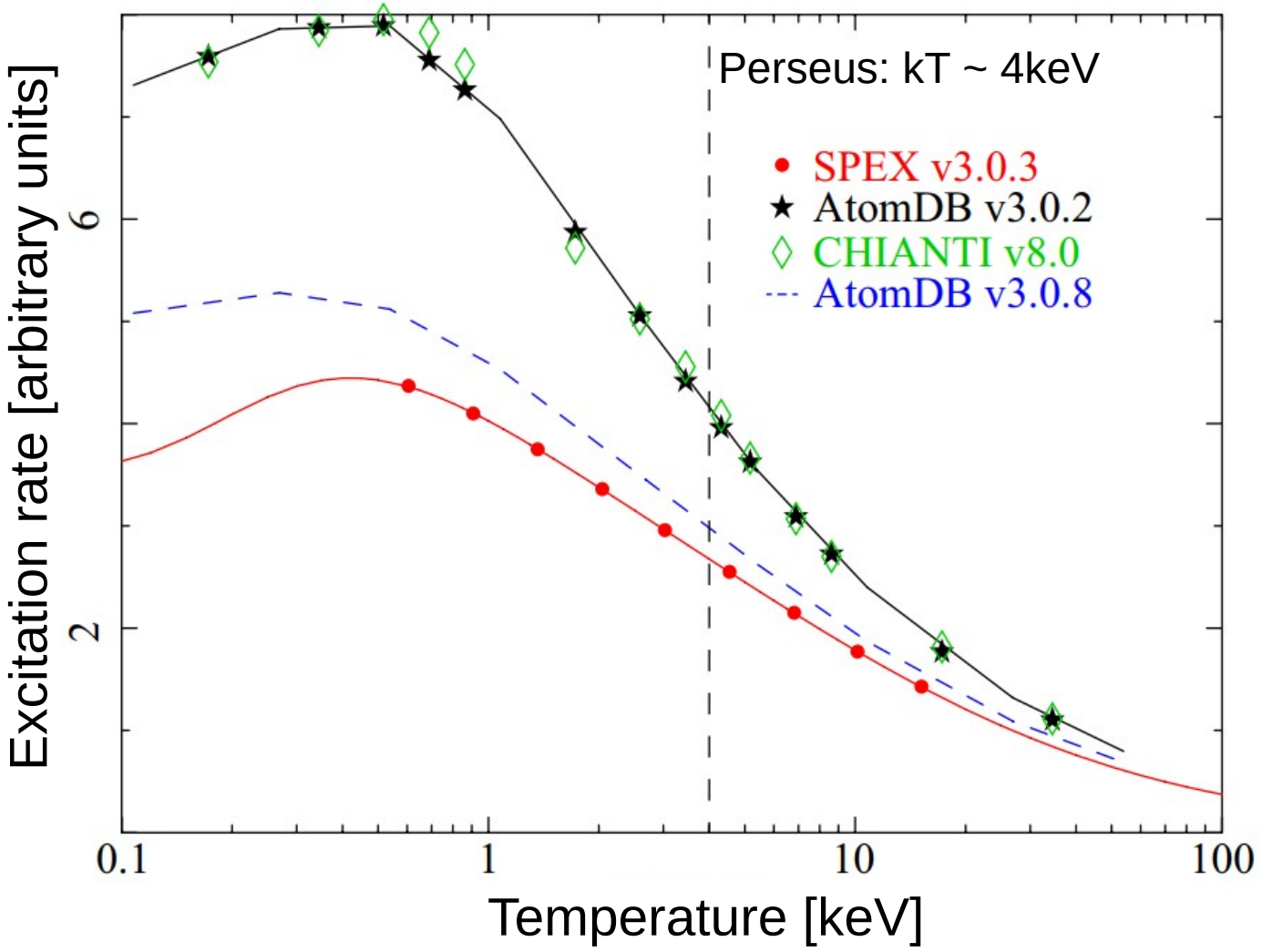
Cooling in the astrophysical sources

- large scale structure
- galaxy clusters & intracluster medium
- galaxies, their outflows & intergalactic medium
- accretion discs
- molecular clouds
- star formation
- white dwarfs
- …

=> cooling is important on various scales

=> our knowledge is limited to accuracy of atomic data

Discrepancies among atomic databases

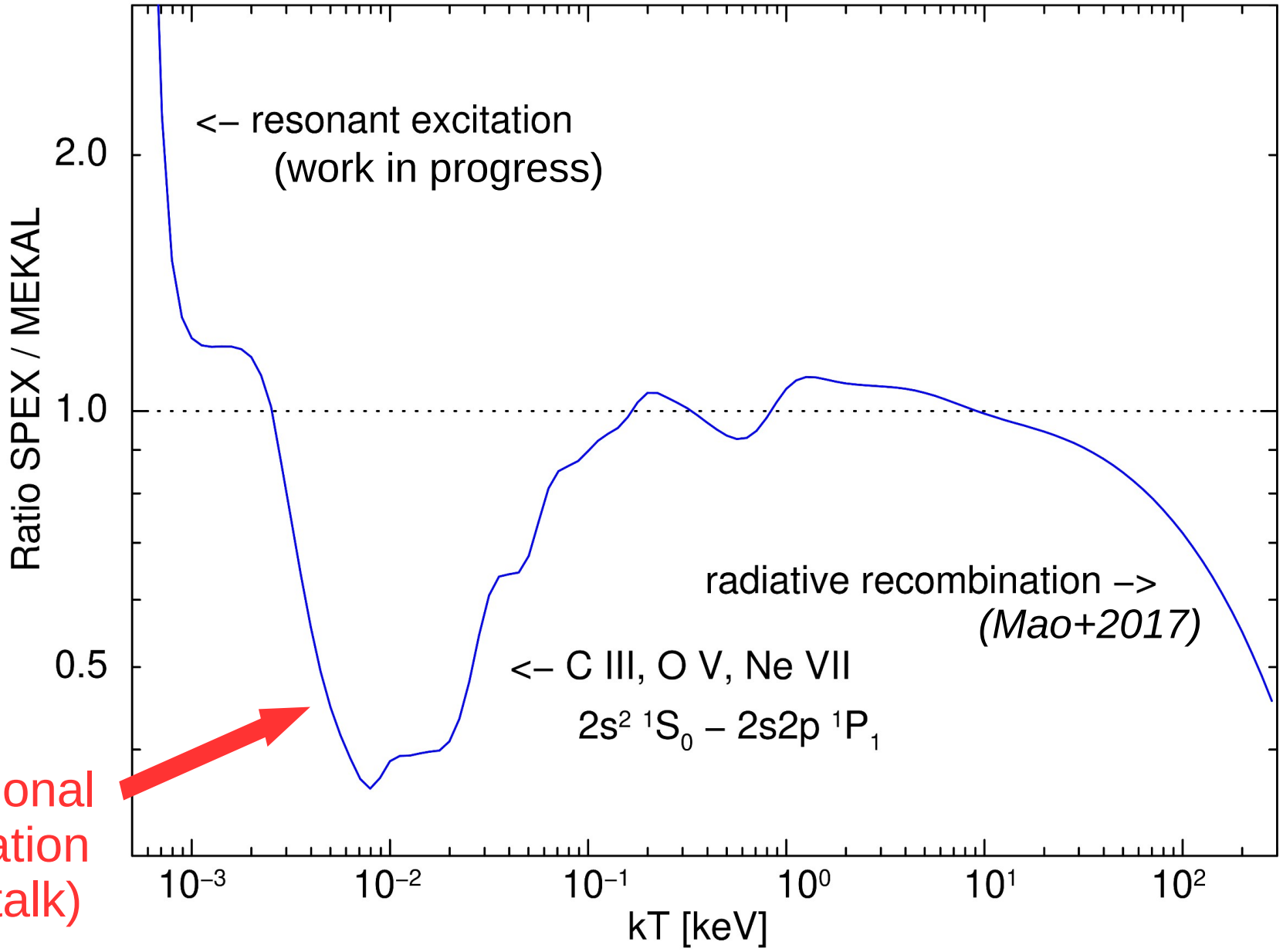


- Fe XXV (He-like)
- $1s^2 \rightarrow 1s\ 2s$

- SPEX vs CHIANTI:
  – 1 keV – factor of 2
  – 10 keV – 40%

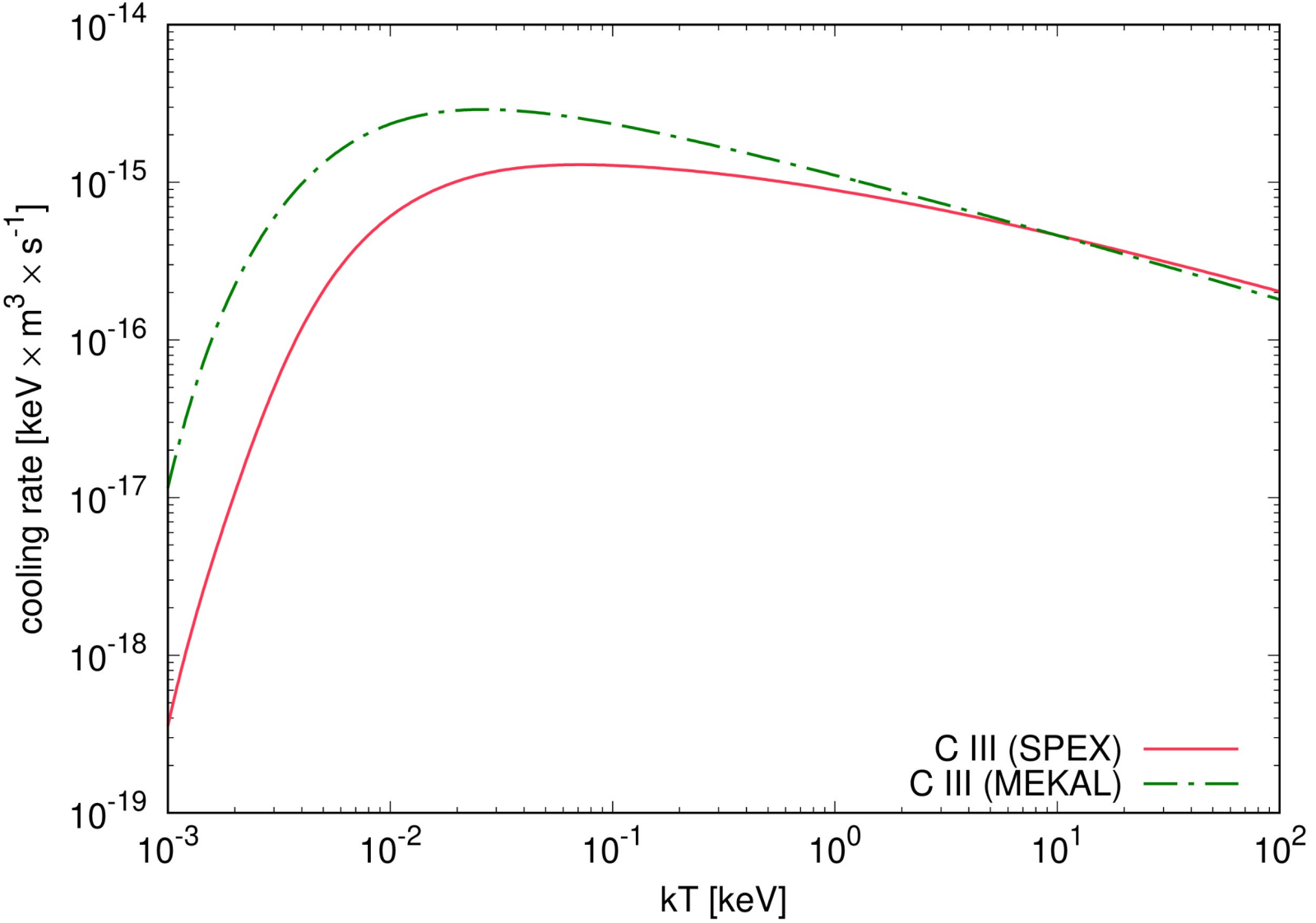
Hitomi Collaboration 2018

Total cooling rate due to line radiation



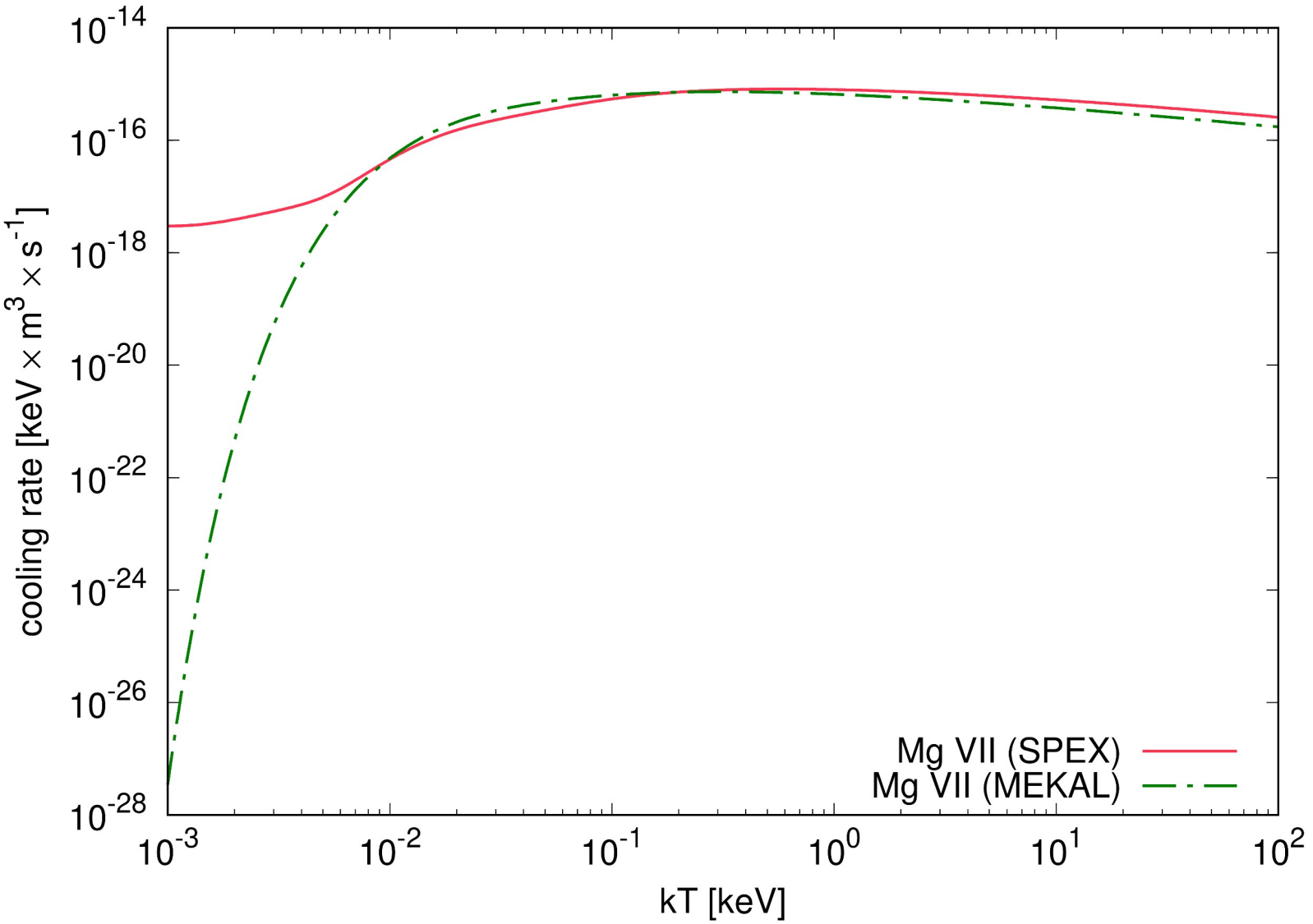
collisional excitation (this talk)

Comparison with MEKAL

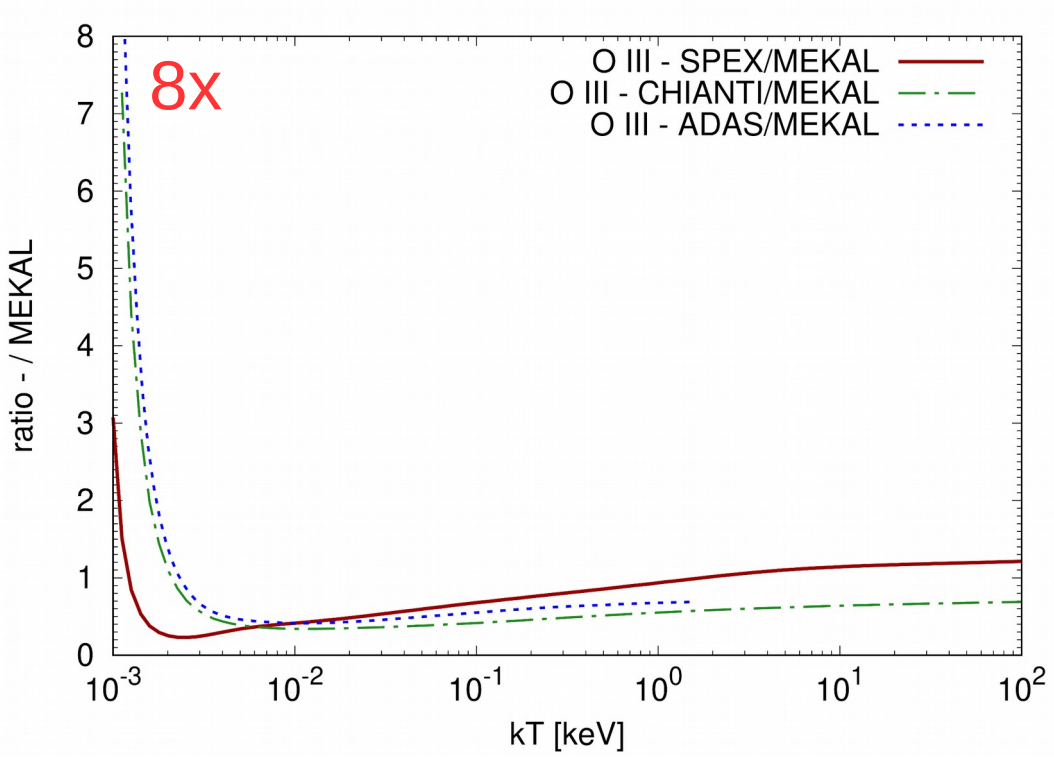


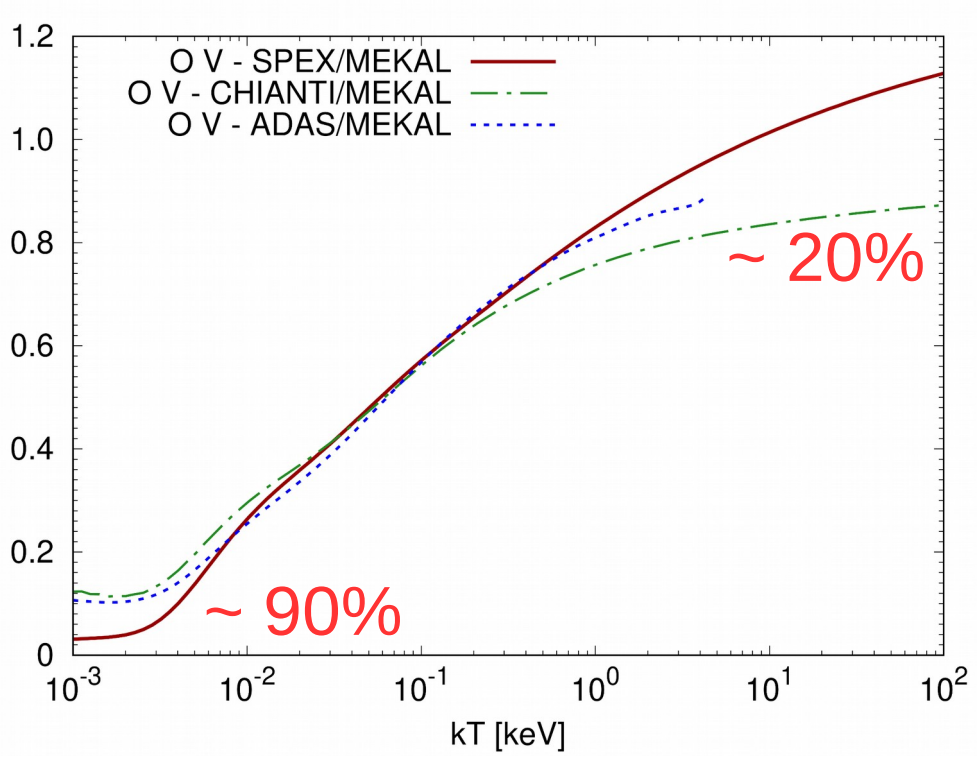
transitions from the ground level to upper levels

Comparison with MEKAL

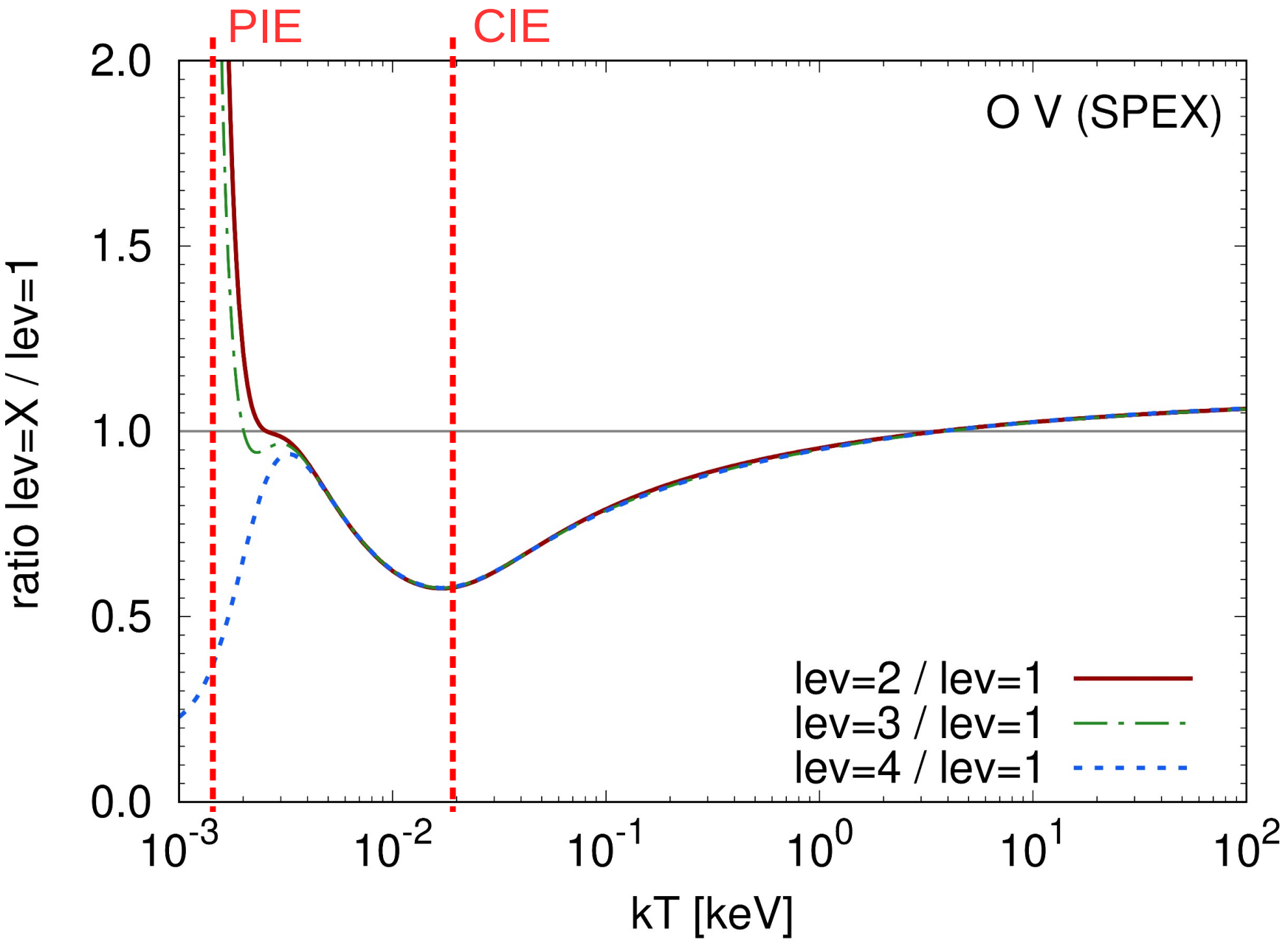


Comparison with CHIANTI & ADAS



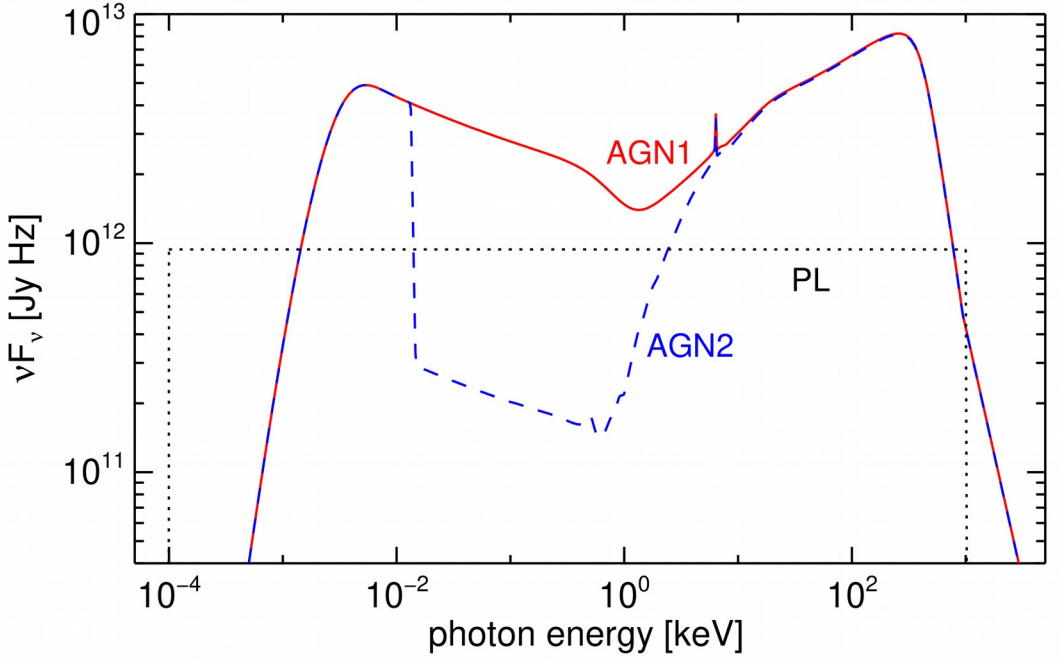


Metastable levels

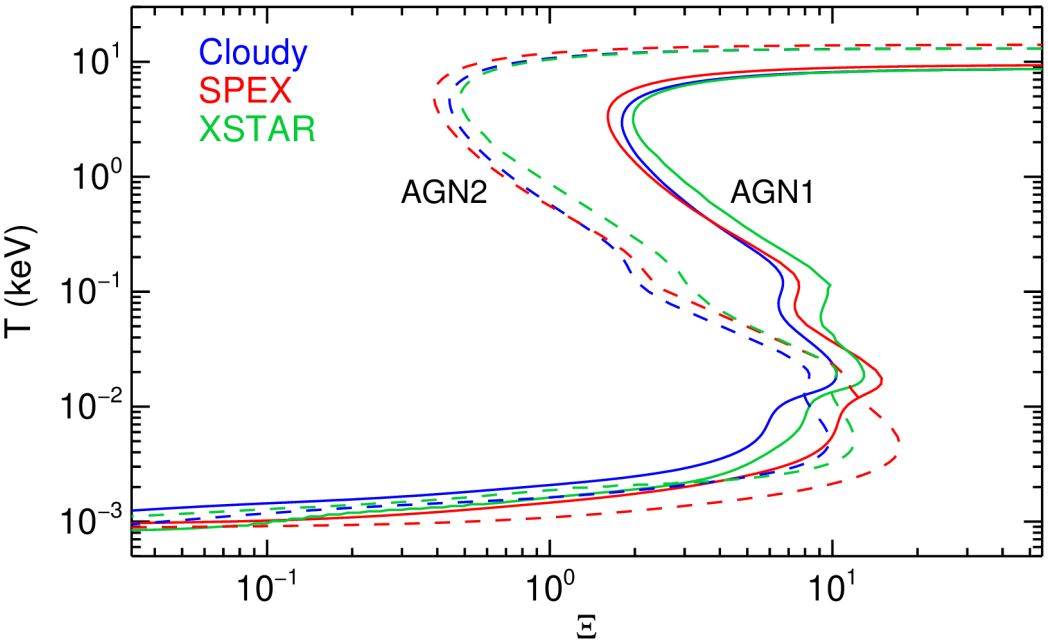


Photoionisation model in SPEX

Used spectral energy distributions



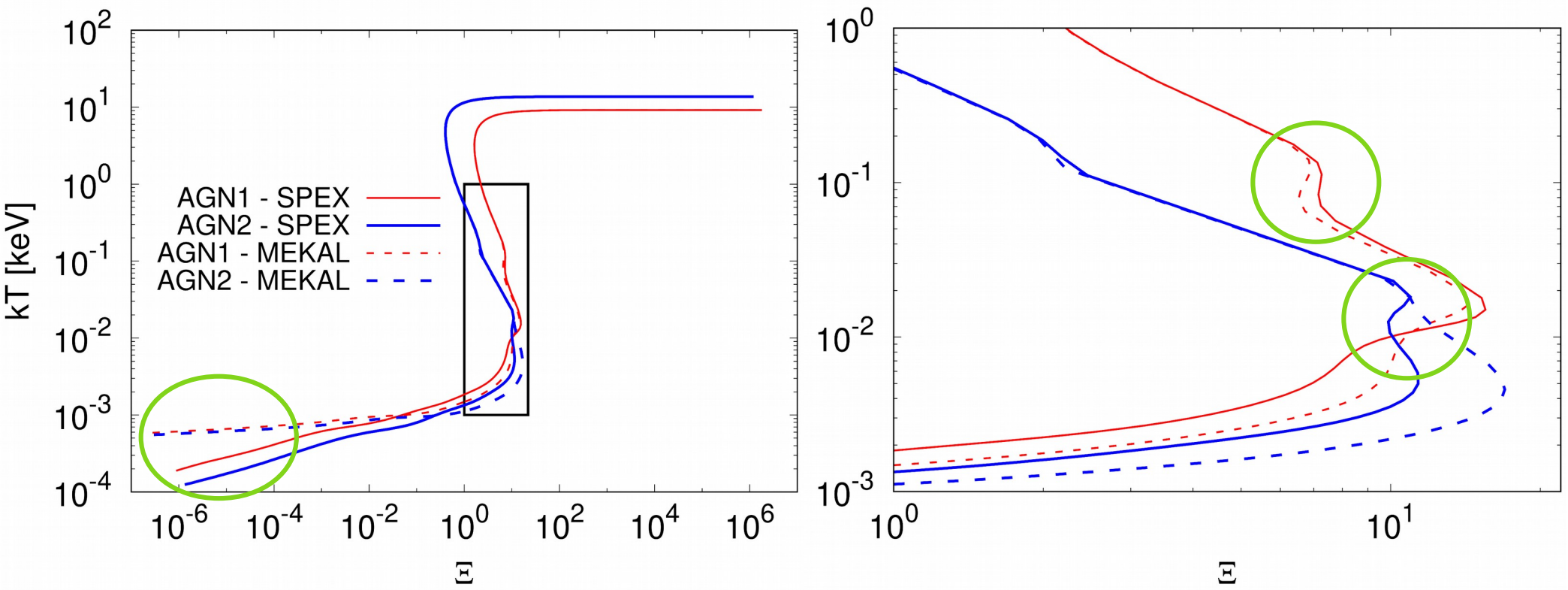
Stability curve of PIE plasma



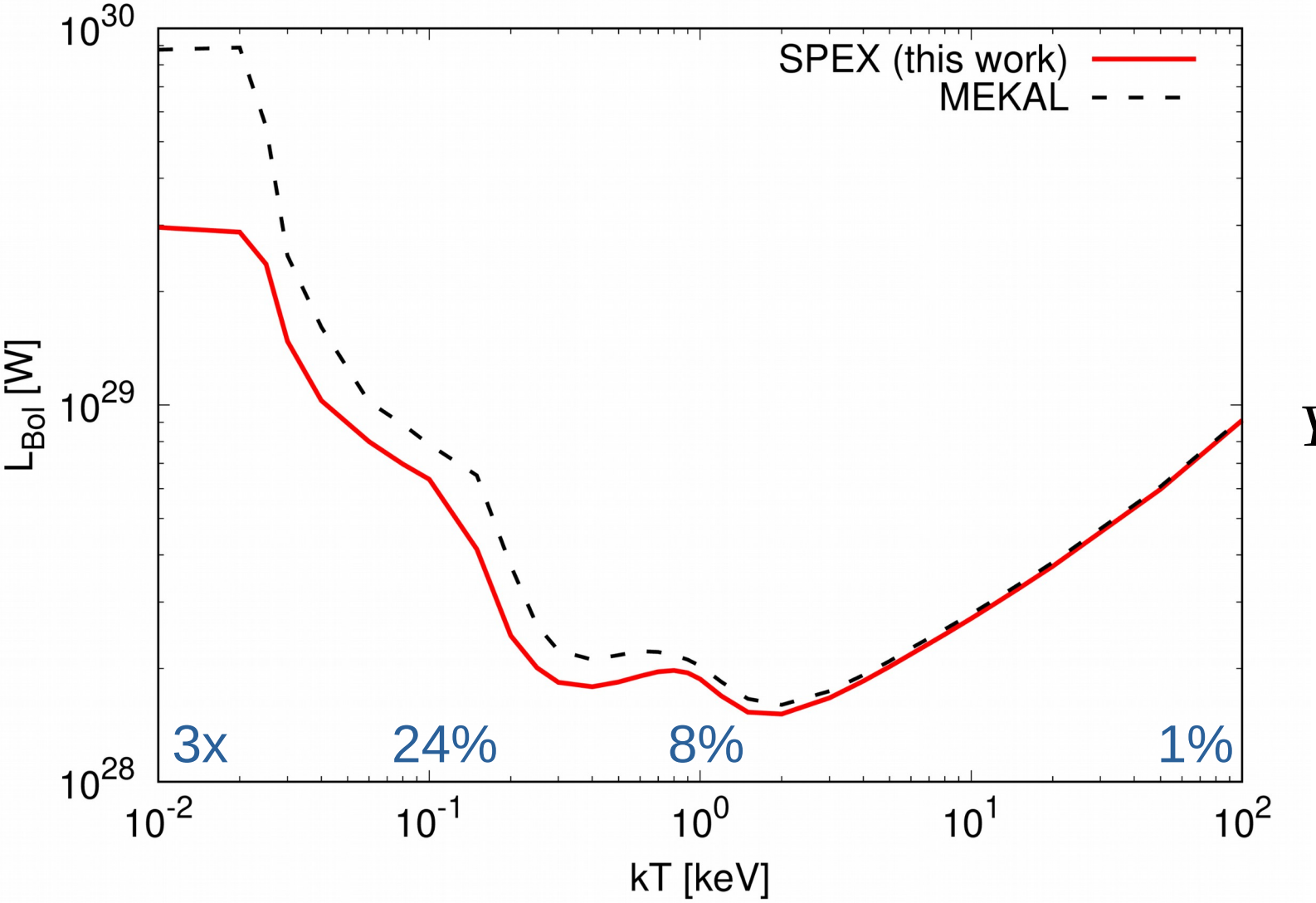
Mehdipour+2016

AGN 1 = unobscured (NGC 5548)
AGN 2 = obscured

New stable branch in S-curve of PIE plasma



Cooling flow model in SPEX (isobaric)



$$Y(T) \propto \frac{\dot{M}}{\Lambda(T)}$$

Conclusions

- excitation rates do not agree among atomic databases
- collisional excitation can significantly impact the cooling rates
- metastable levels important for cooling (Be-like, B-like, ...)
- new cooling rates:
  - new stability branches of PIE plasma
  - at low $\Xi \rightarrow$ lower plasma temperature in PIE equilibrium
  - higher differential emission measure in cooling flow model
- near future: resonant excitation