

Kinematically misaligned HI in early-type galaxies

Paolo Serra

single dishes

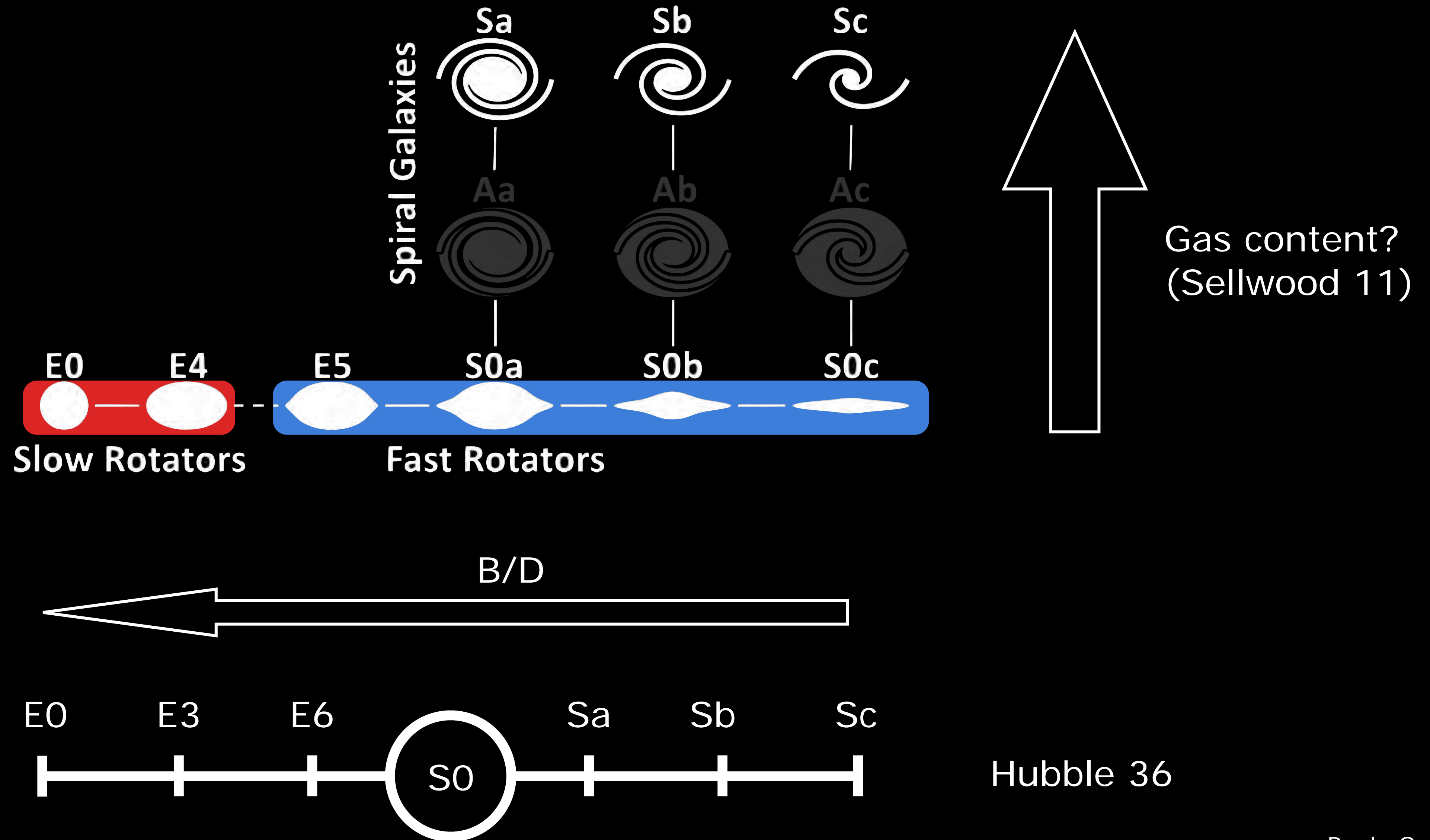
Gouguenheim 1969
Bottinelli et al. 1970, 1973
Balkowski et al. 1972
Gallagher 1972
Gallagher, Faber & Balick 1975
Balick, Faber & Gallagher 1976
Bieging & Biermann 1977
Knapp et al. 1977, 1978, 1979
Biermann, Clarke & Fricke 1979
Krumm & Salpeter 1979
Sanders 1980
Knapp, Turner & Cunniffe (1985)
Wardle & Knapp (1986)
Sadler, Oosterloo & Morganti 2002
di Serego Alighieri et al. 2007
Grossi et al. 2009

interferometers

Shane 1980
Raimond et al. 1981
Knapp & Raimond 1984
Sancisi et al. 1984
van Gorkom et al. 1986
Lake, Schommer & van Gorkom 1987
Shostak 1987
Kim et al. 1988
van Driel & van Woerden 1991
Schiminovich et al. 1994, 1995
van Gorkom & Schiminovich 1997
Sadler et al. 2000
Hibbard et al. 2001, 2003
Oosterloo et al. 2002
Morganti et al. 2006
Oosterloo et al. 2007, 2010

... and many more!

Parallel sequences of ETGs and spirals

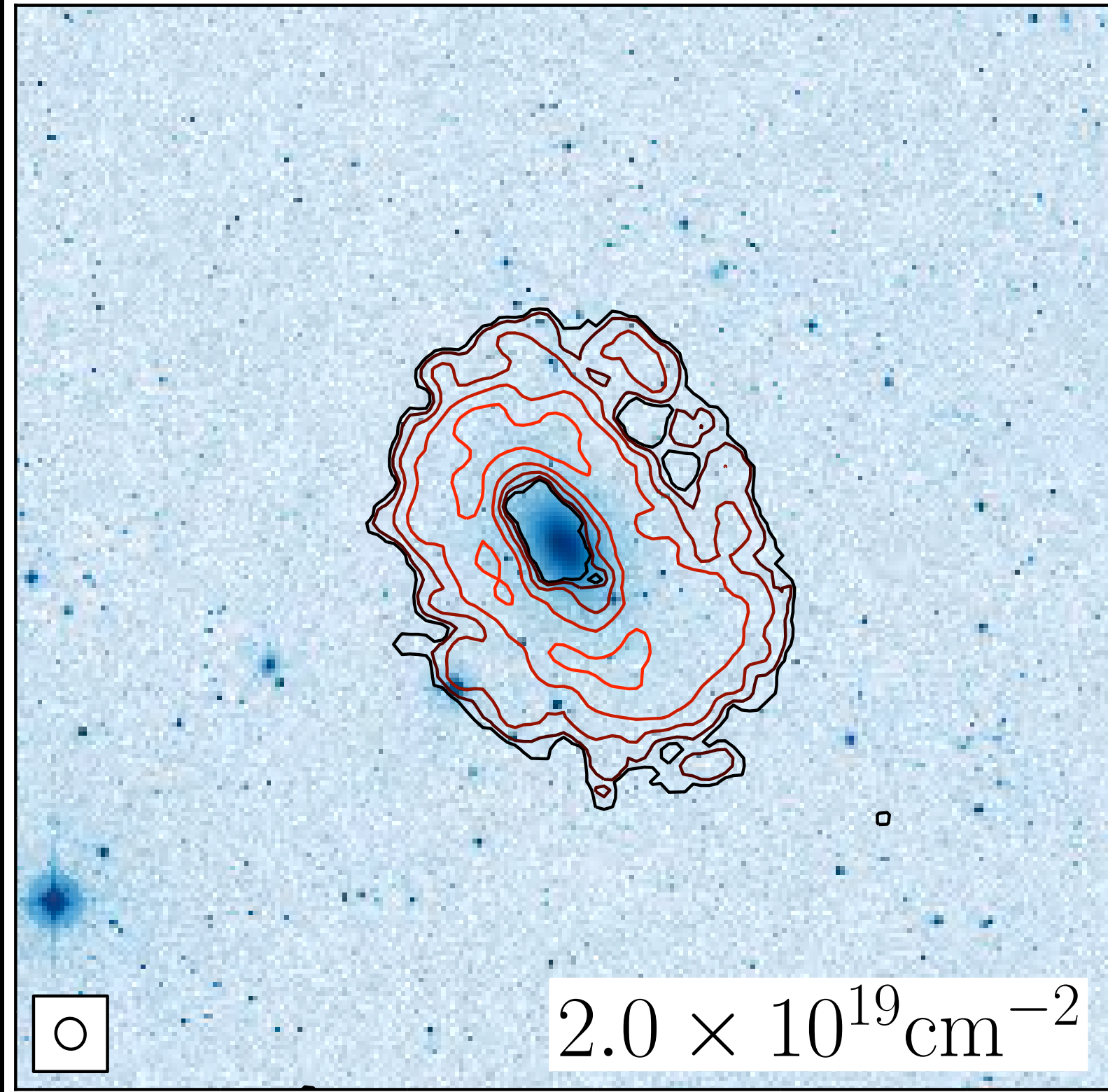




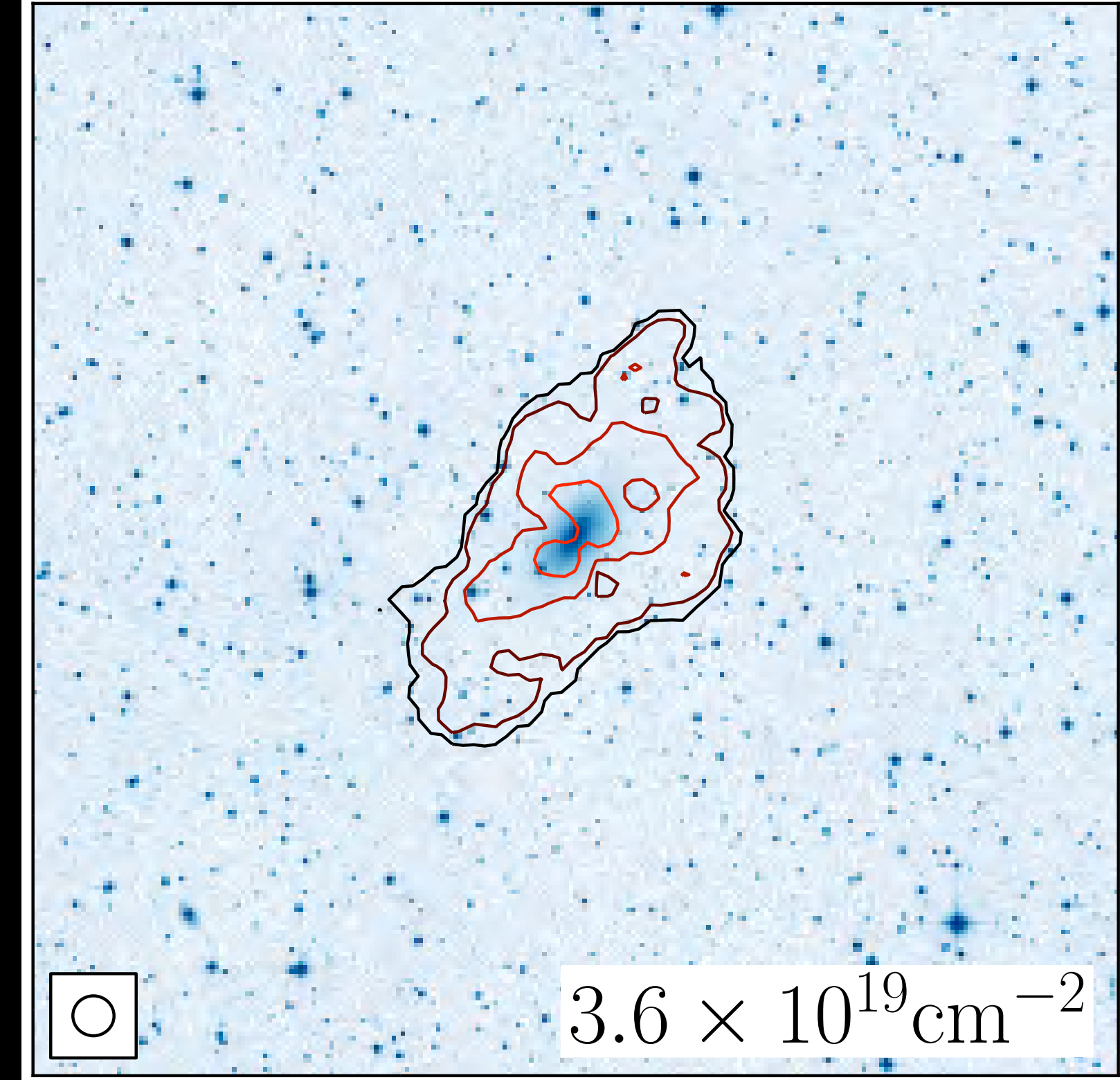
166 ETGs
(39 Virgo, 127 non-Virgo)
sensitivity $\sim 10^7 M_{\odot}$, $\sim 3 \times 10^{19} \text{ cm}^{-2}$

Serra+ 12, MNRAS, 422, 1835

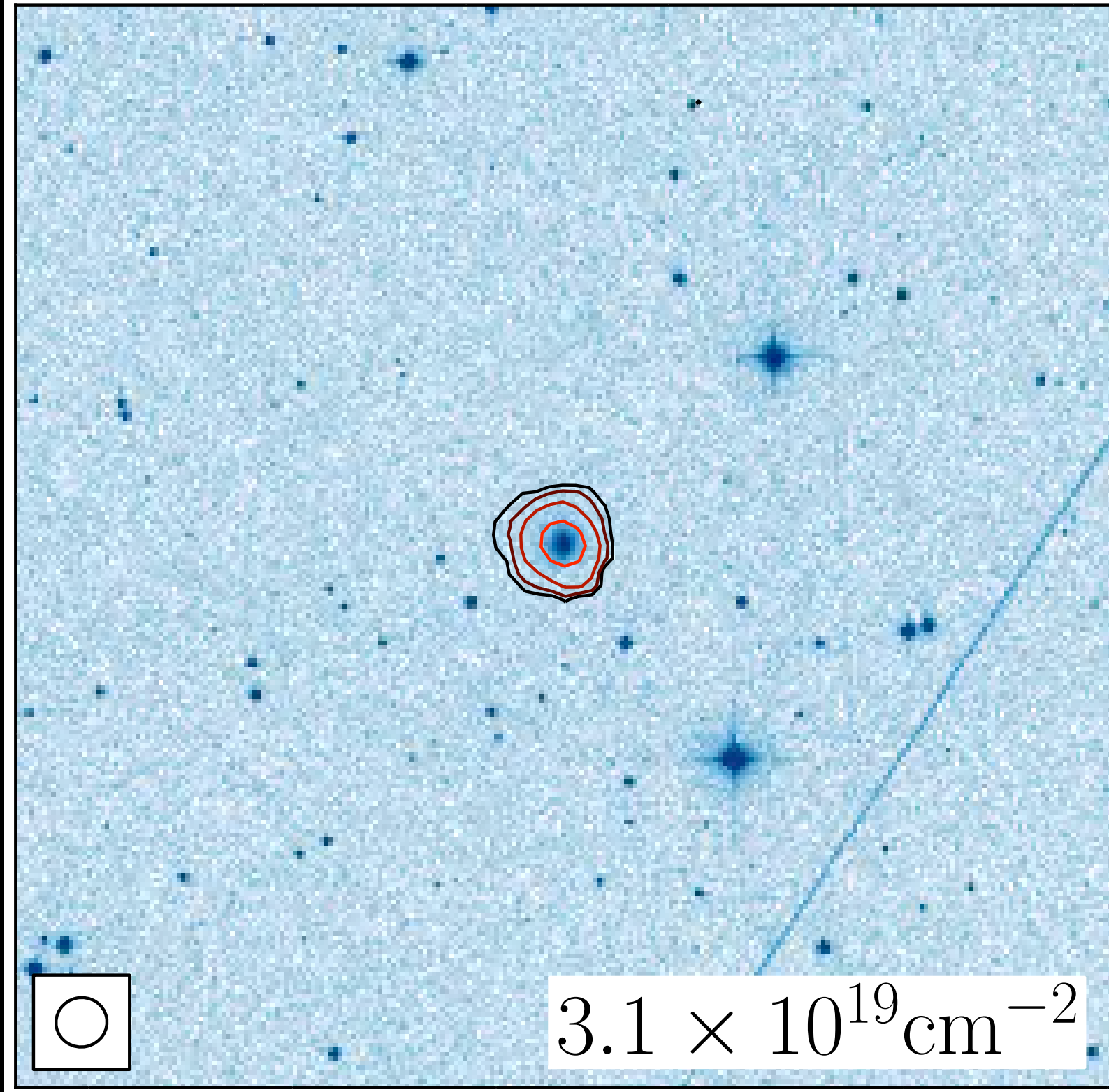
NGC 5582 (*D*)



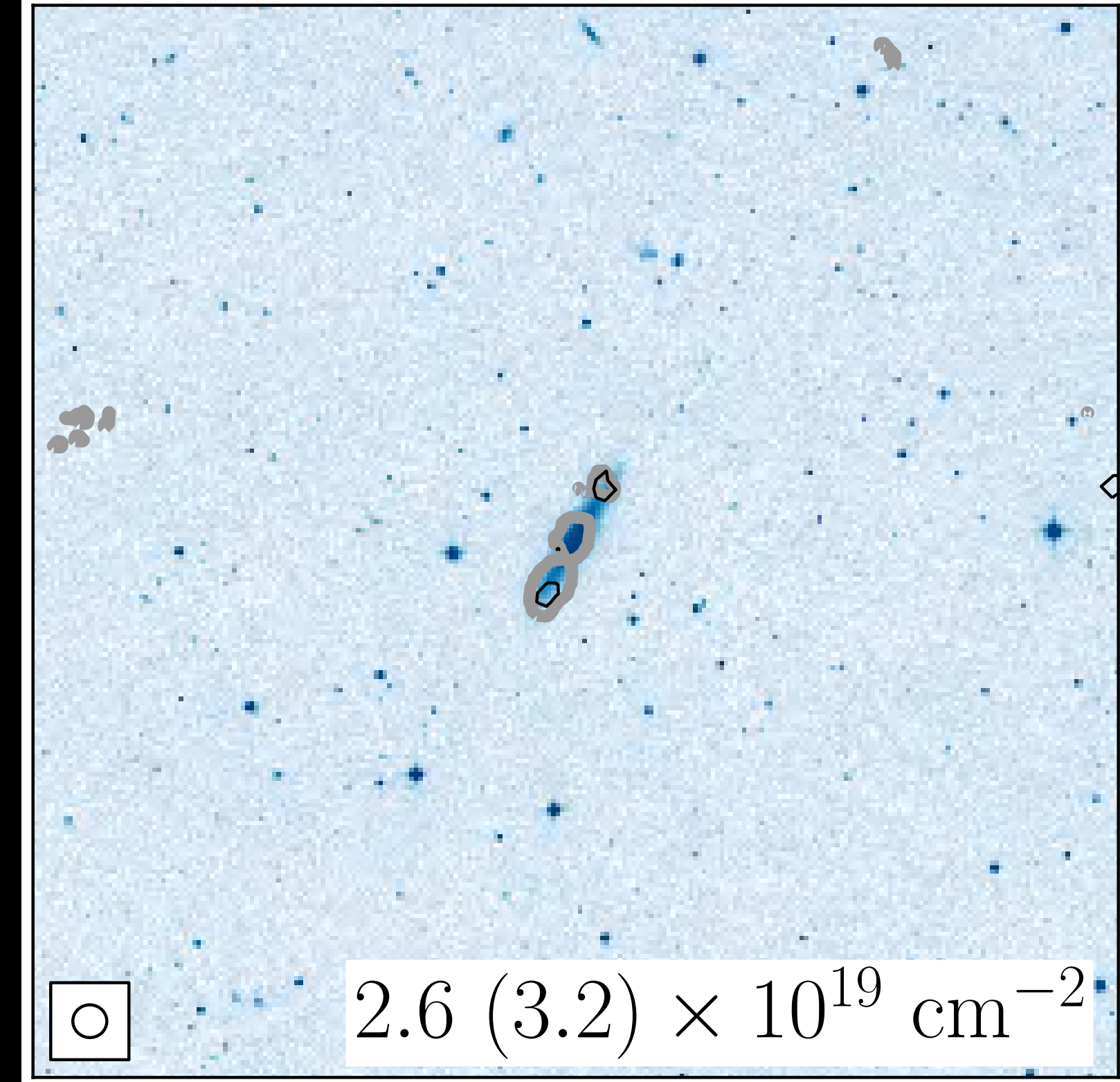
NGC 6798 (*D*)



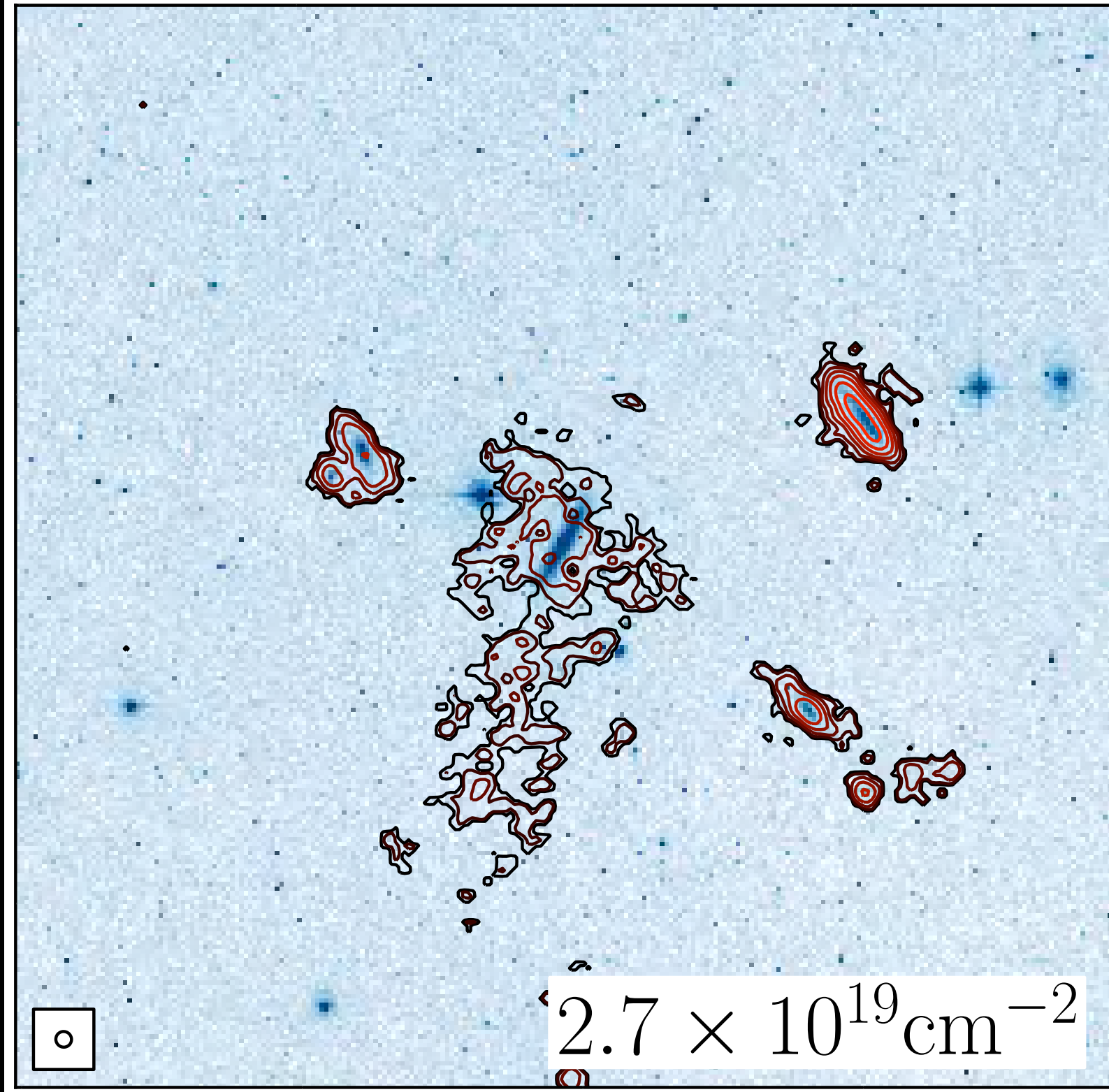
UGC 05408 (*d*)



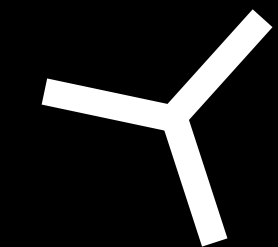
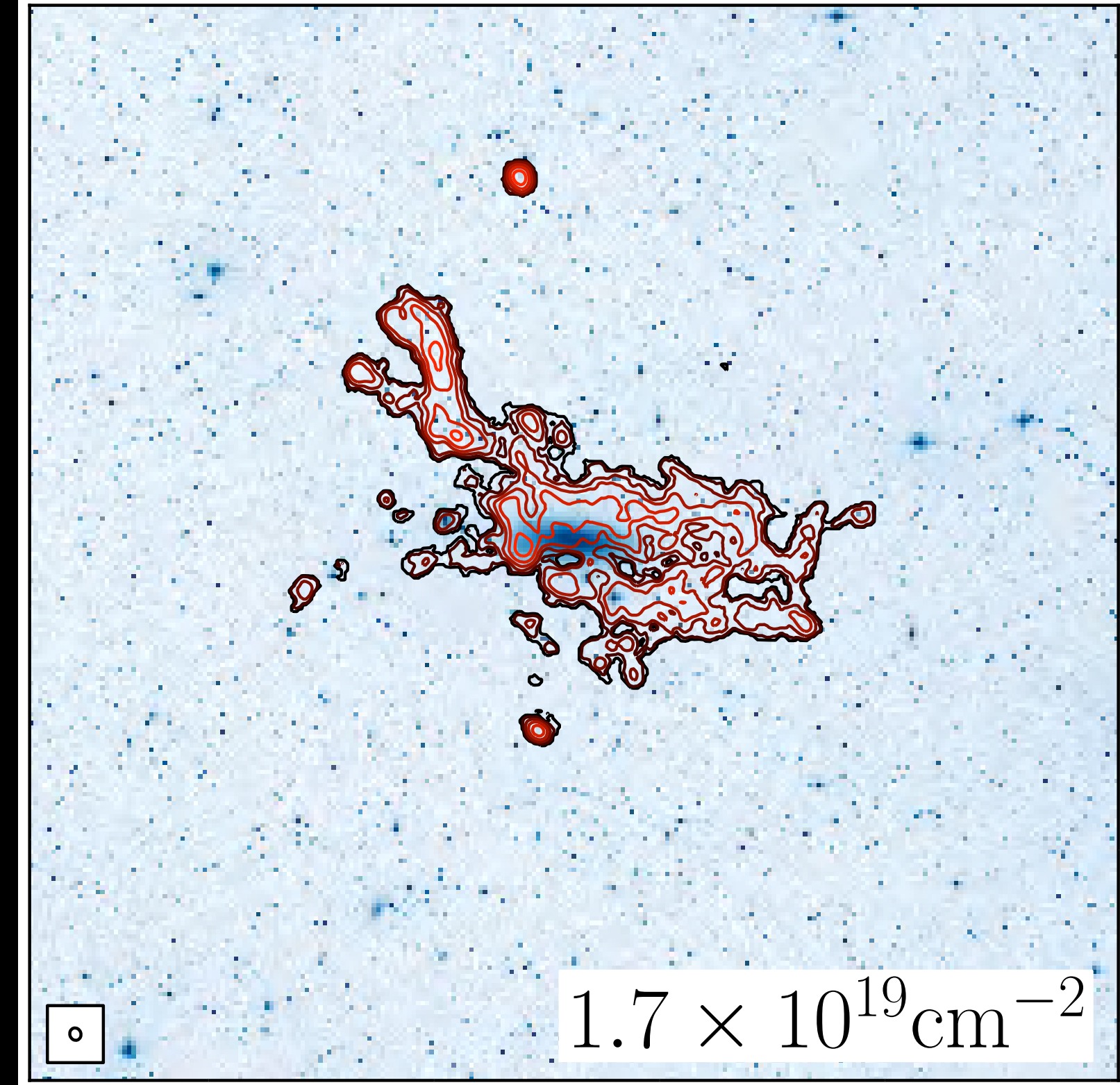
NGC 5422 (*d*)

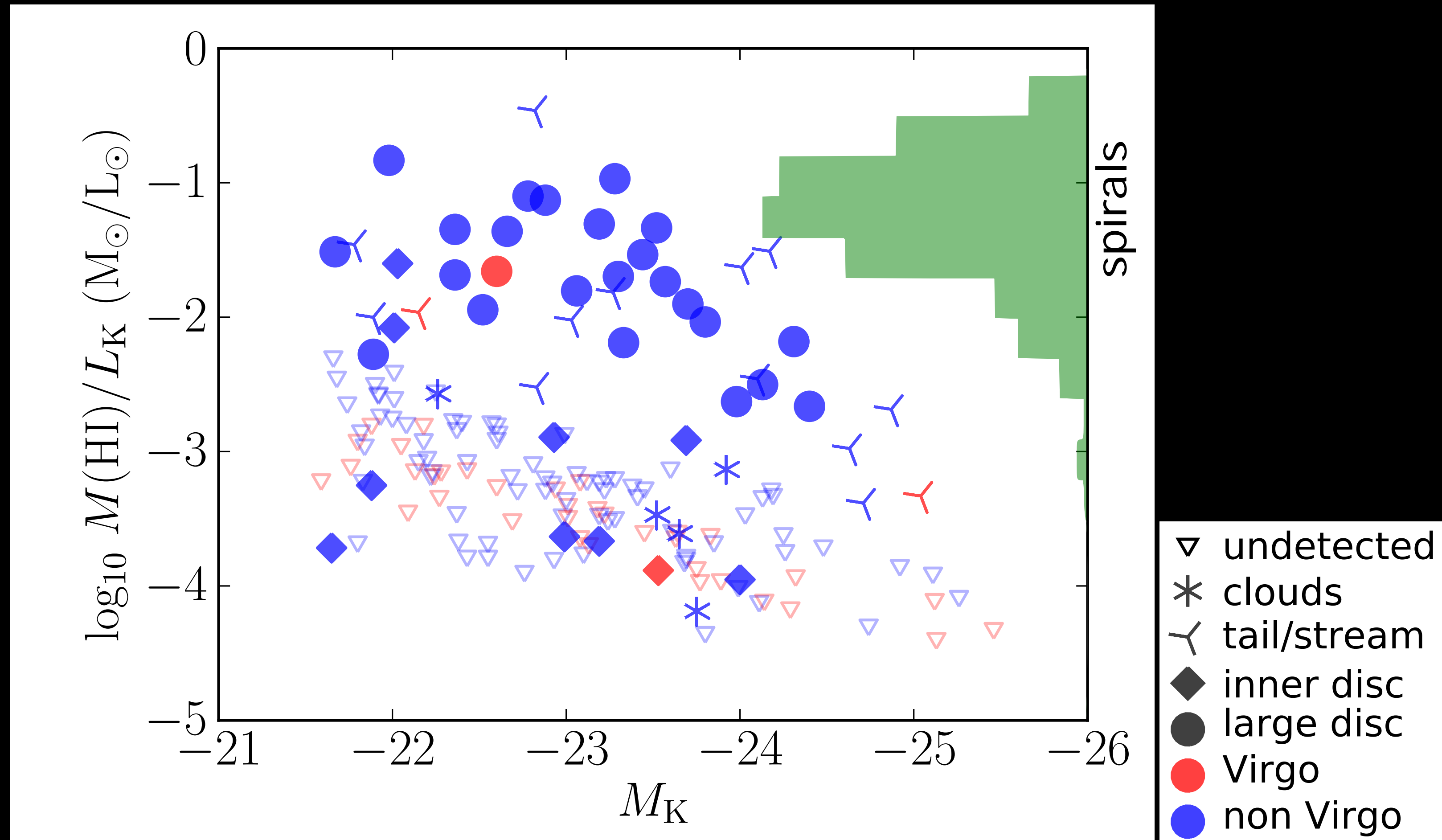


NGC 4111 (u)

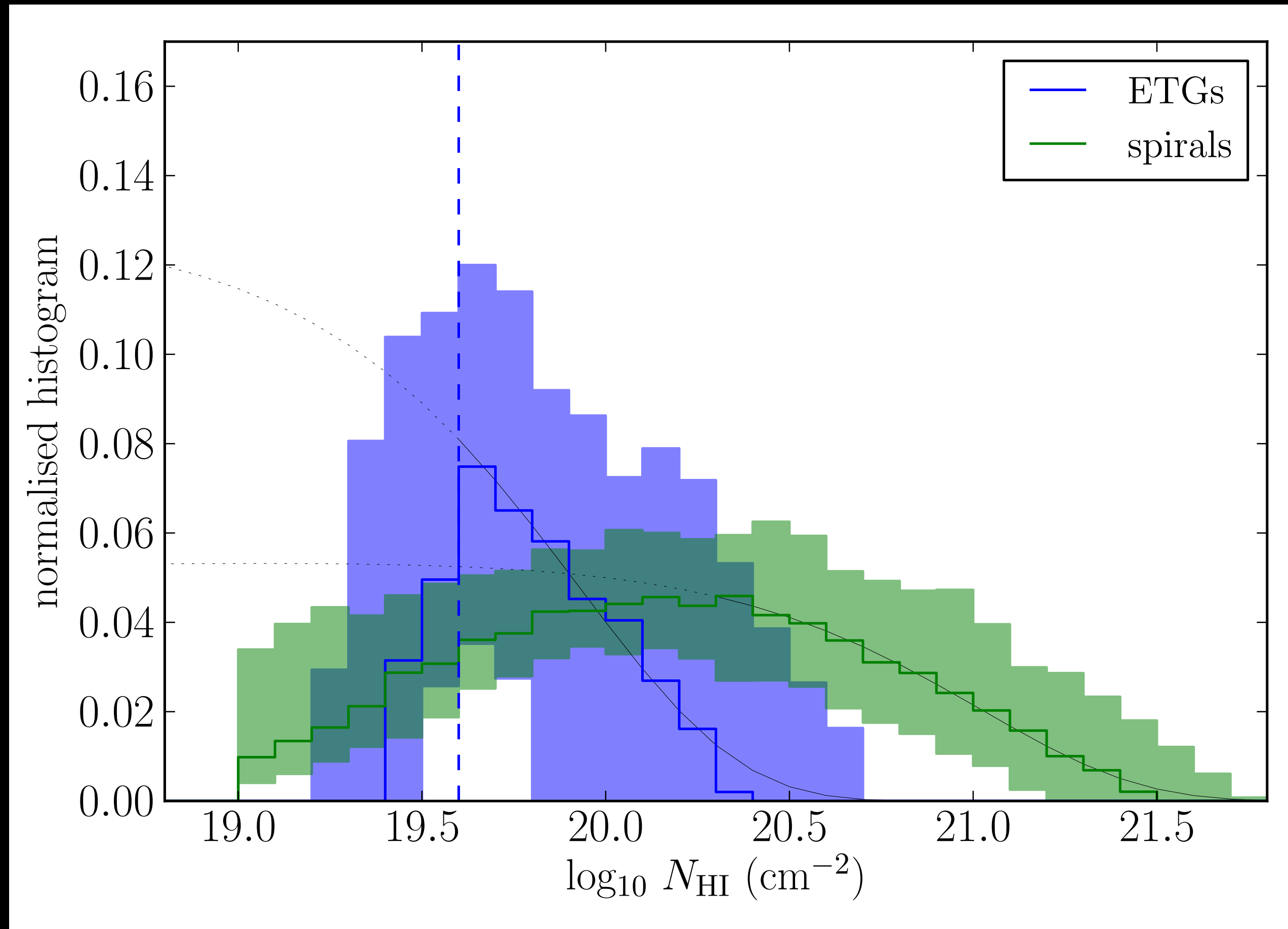


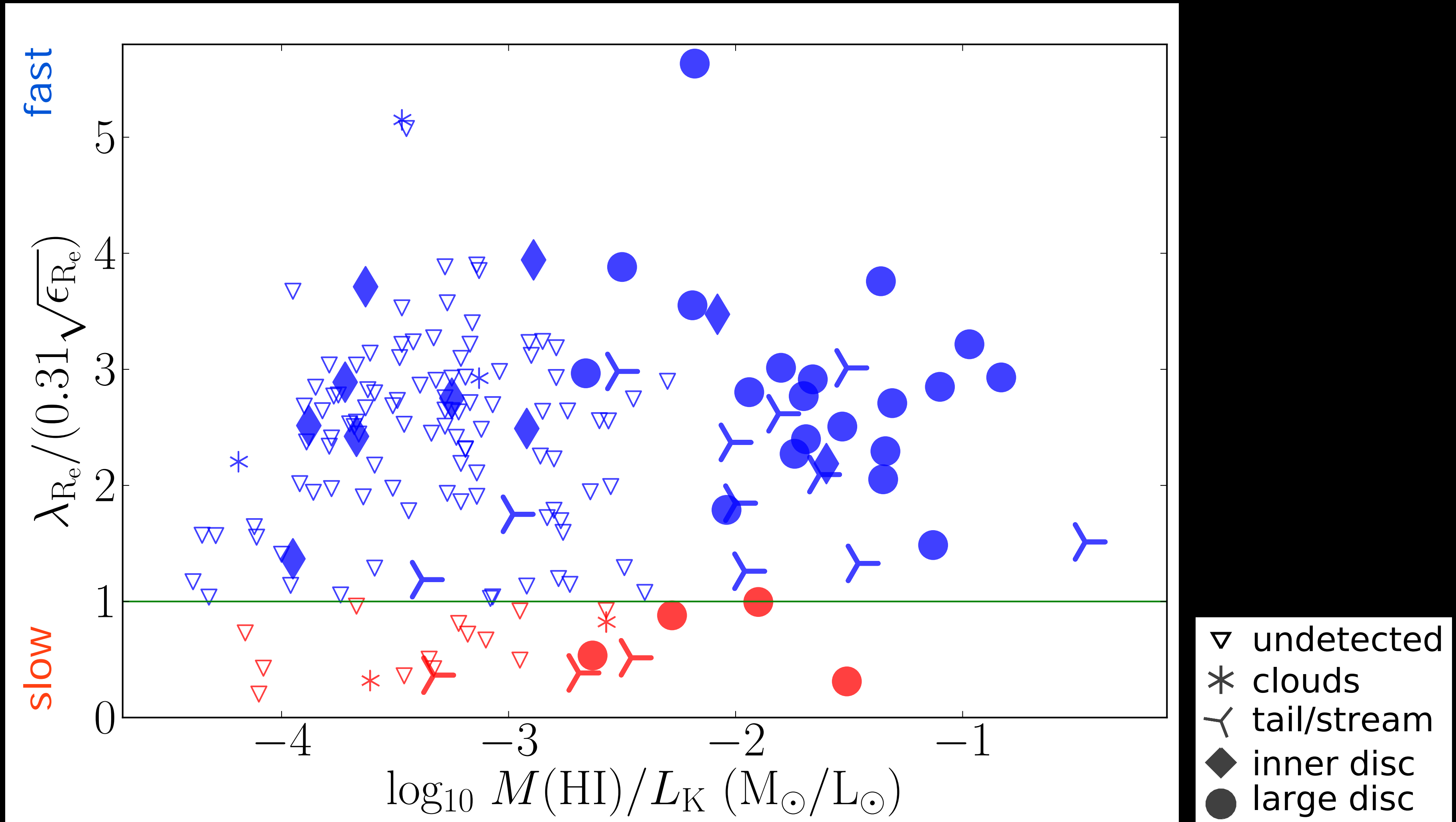
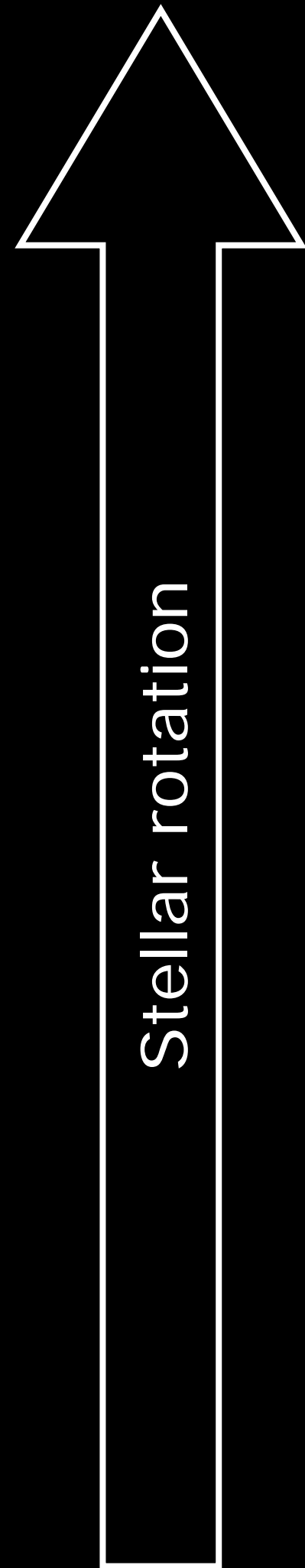
NGC 1023 (u)

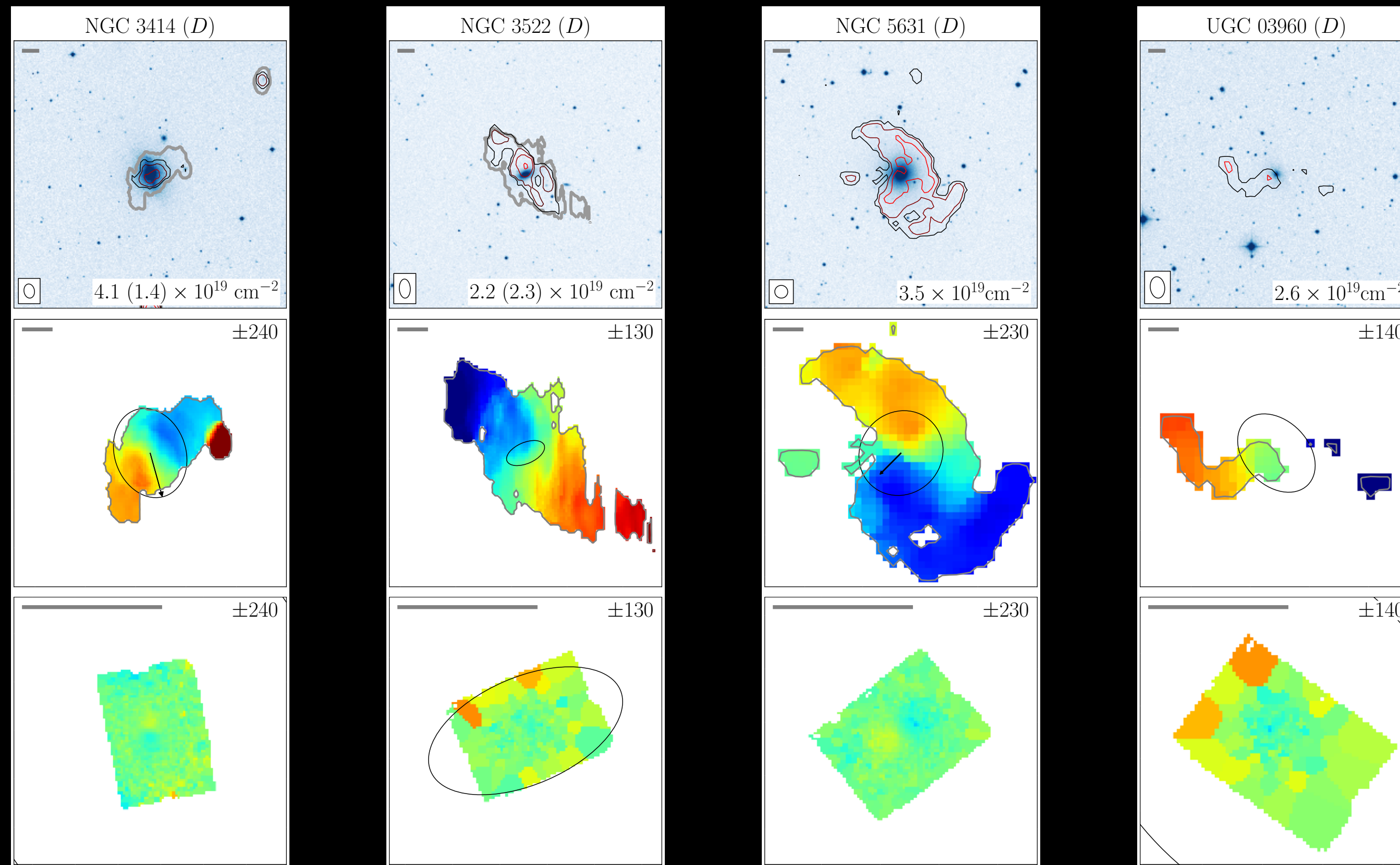




The decisive difference between ETGs and spirals







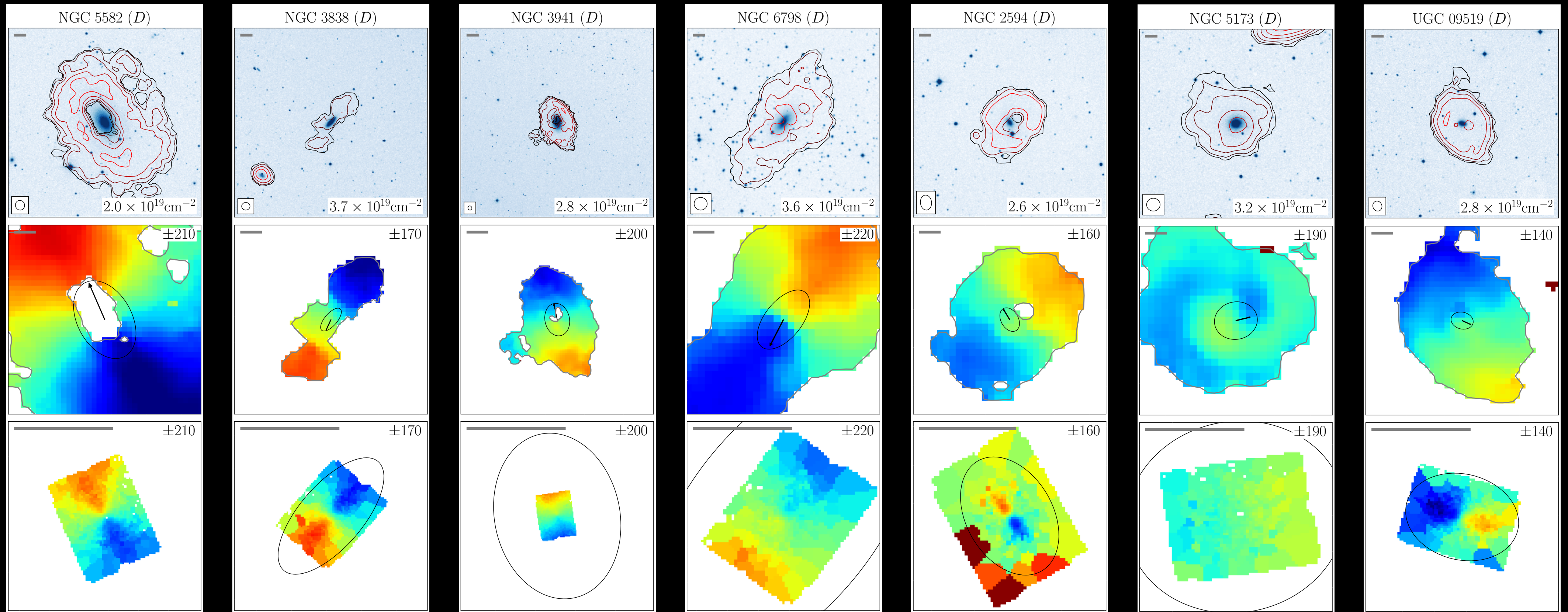
Misaligned HI discs in fast rotators

co-rotation

counter-rotation

polar

warp/other



50%

12%

12%

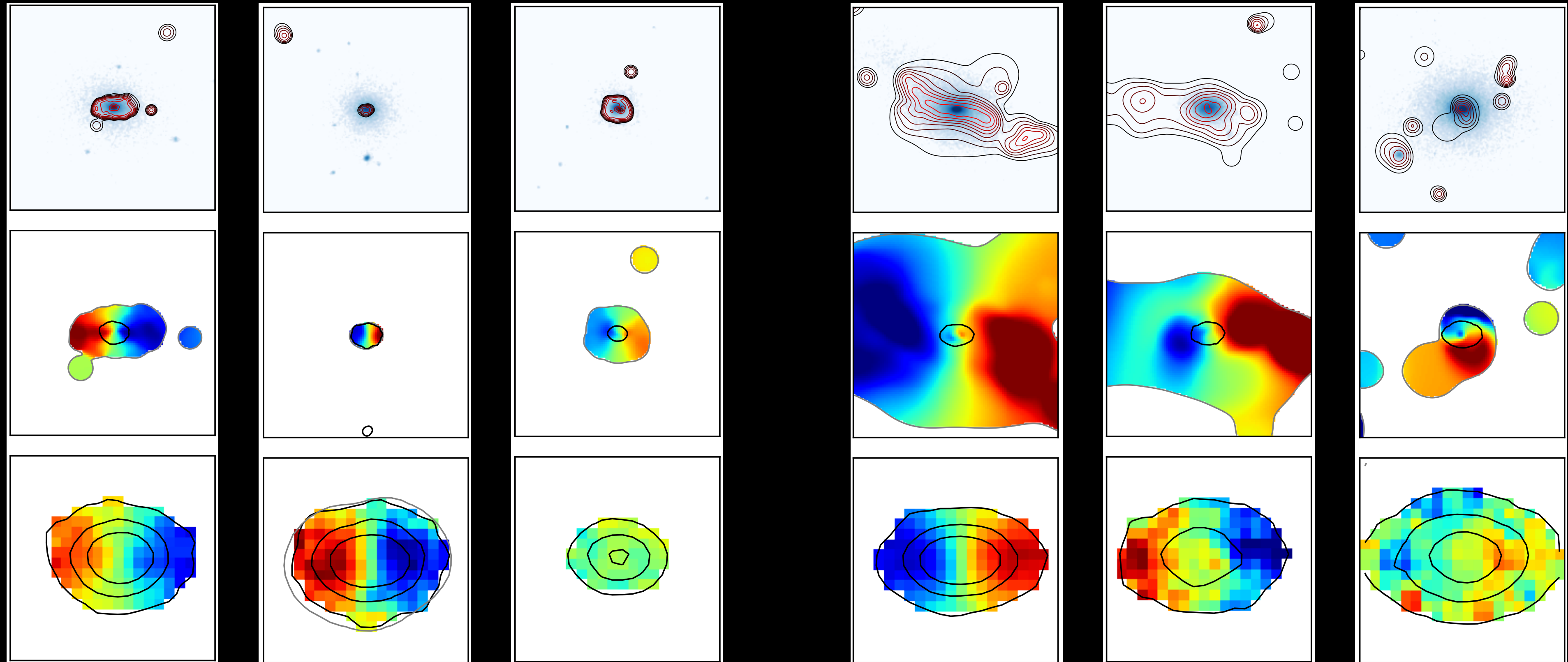
25%

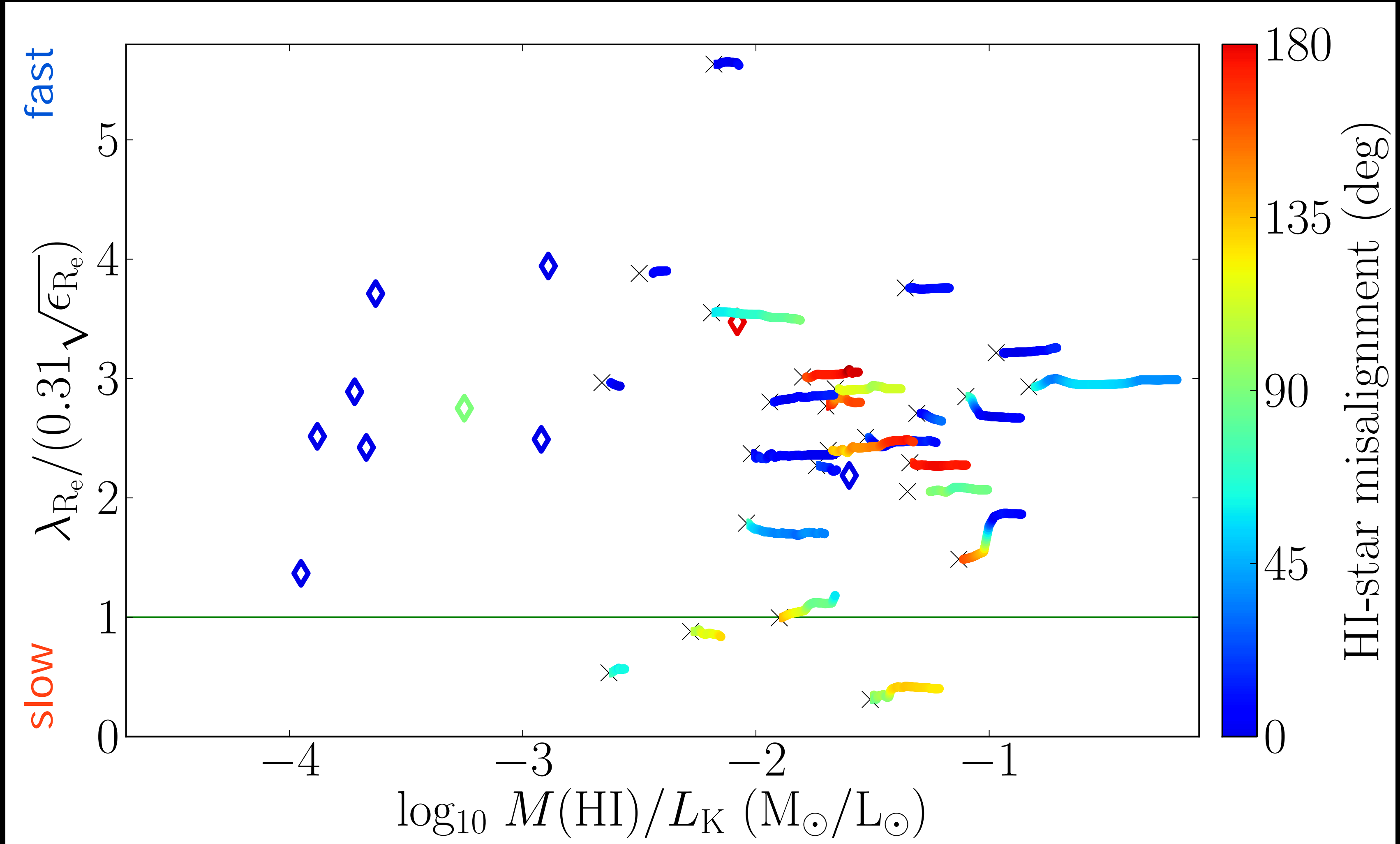
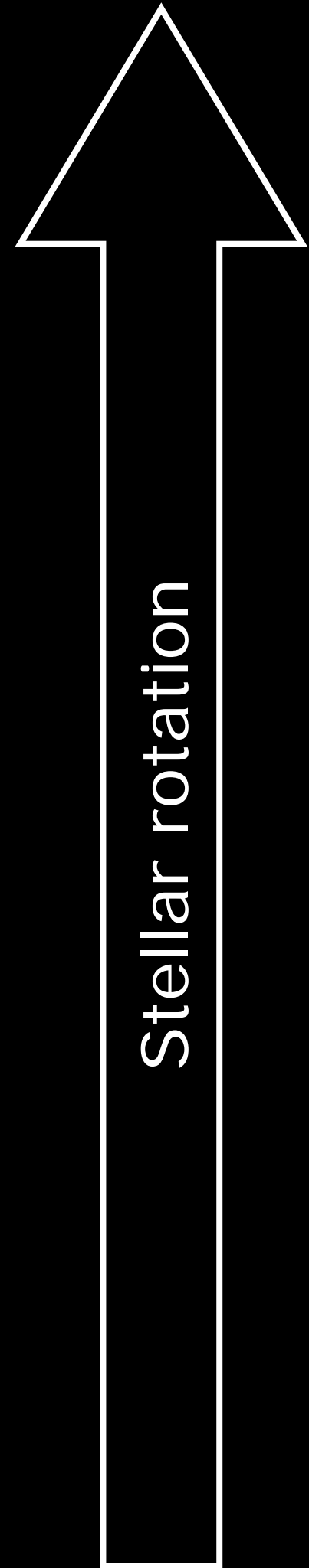
Serra+ in prep

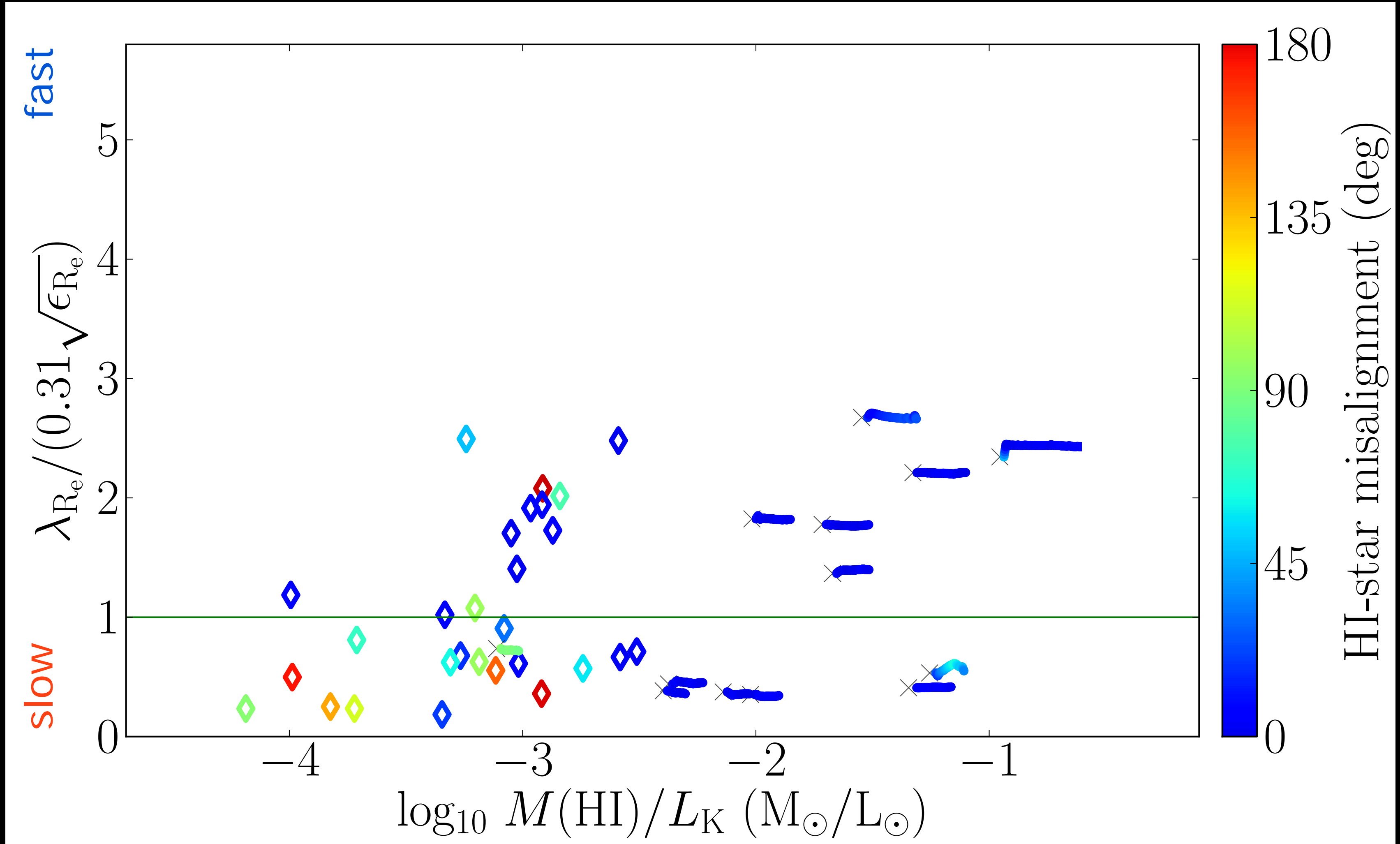
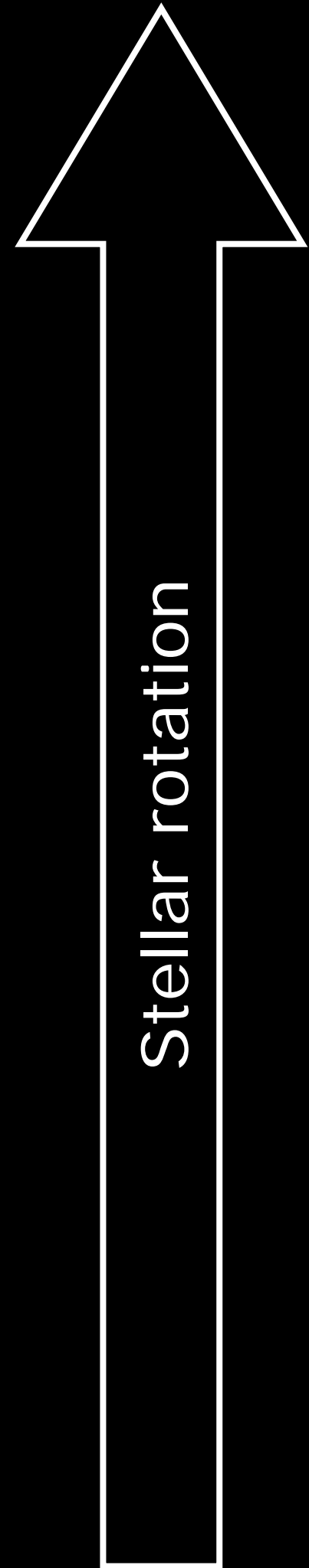
Simulations by Naab, Oser

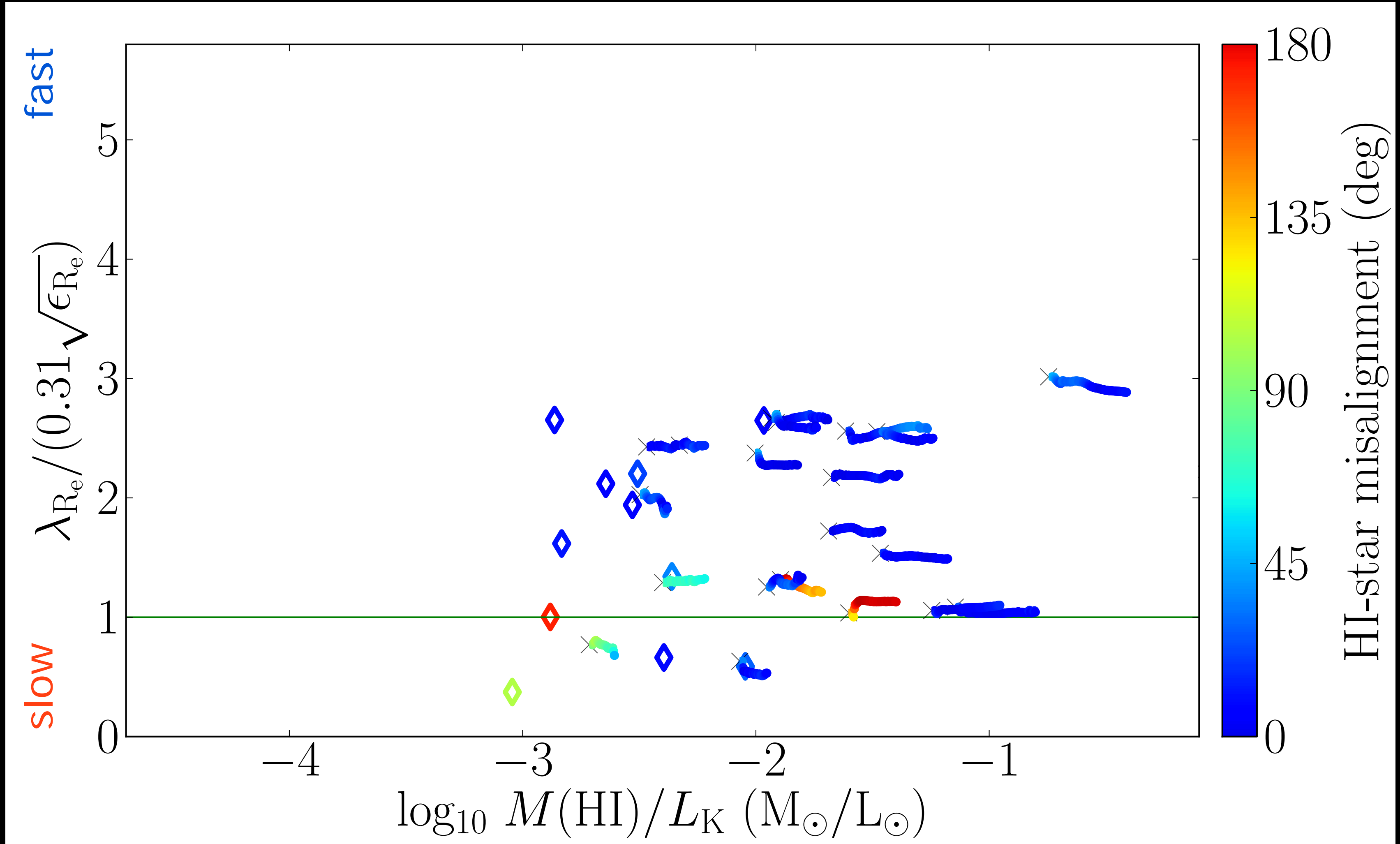
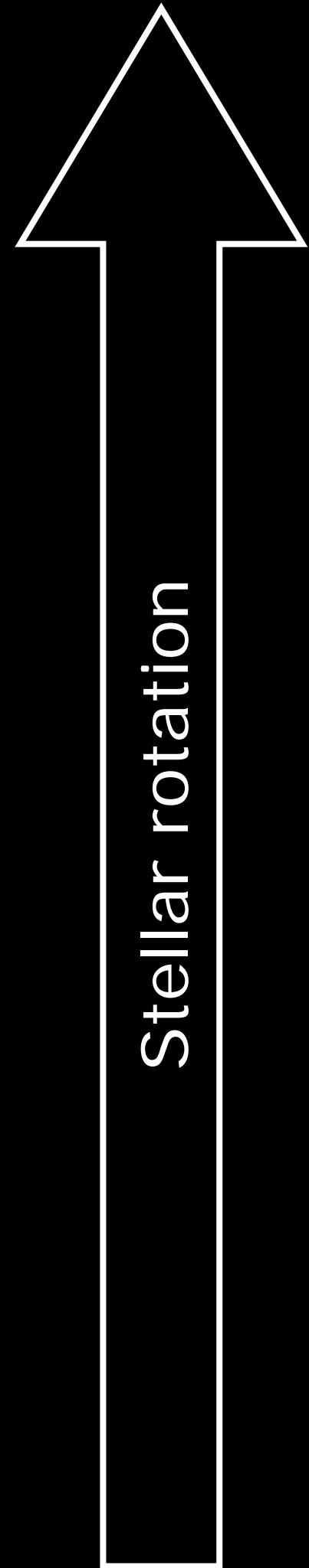
without galactic winds

with galactic winds









- HI in 40% of all ETGs outside Virgo. HI discs in ~25%. $R \sim 1-10$'s kpc, $M(\text{HI}) \sim 10^6 - 10^9 M_{\odot}$
- Difference from spirals: 1) low $M(\text{HI})$, 2) low HI surface density. Support for ETG-spiral parallel sequences. High angular momentum gas accretion.
- Large diversity of kinematical misalignment. Challenge for simulations.
- Bright future – large HI and IFU surveys.