



Astronomy and Space Science

HI discs in early-type galaxies

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HI in ETGs: a long history

single dish

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

interferometer

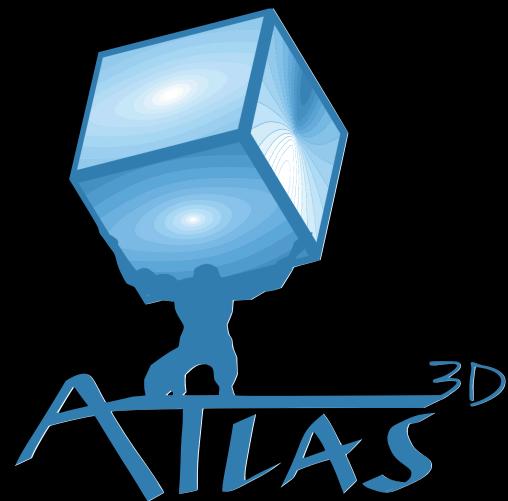
Shane 1980
Raimond et al. 1981
Knapp & Raimond 1984
Sancisi et al. 1984
van Gorkom et al. 1986
Lake, Schommer & van Gorkom 1987
Shostak 1987
Kim et al. 1988
van Driel & van Woerden 1991
Schiminovich et al. 1994, 1995
van Gorkom & Schiminovich 1997
Sadler et al. 2000
Hibbard et al. 2001, 2003
Oosterloo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

... and many more!

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ATLAS^{3D} HI survey



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

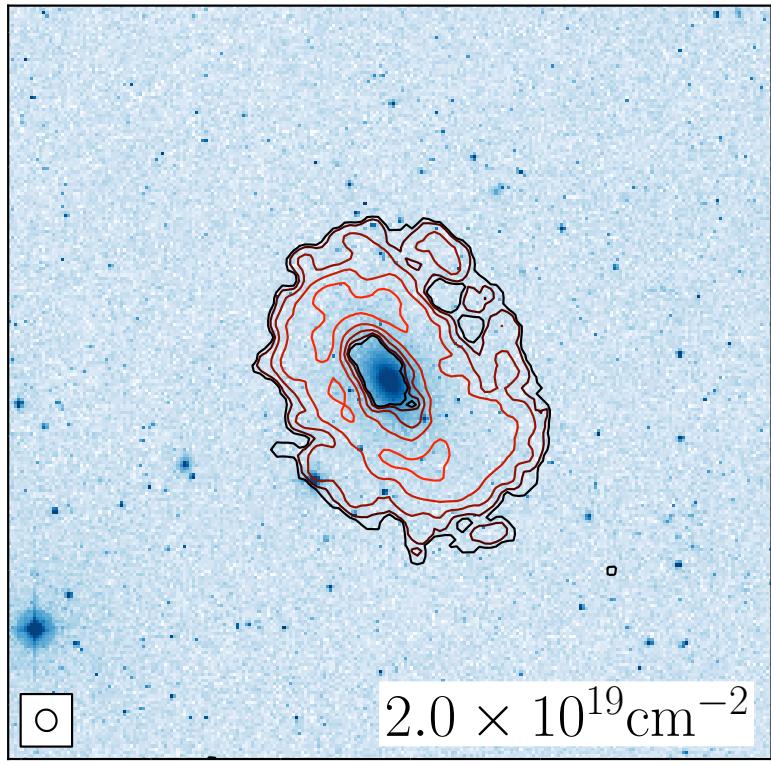
outside Virgo

HI in 40% of all ETGs ; HI discs in 1/4 of all ETGs

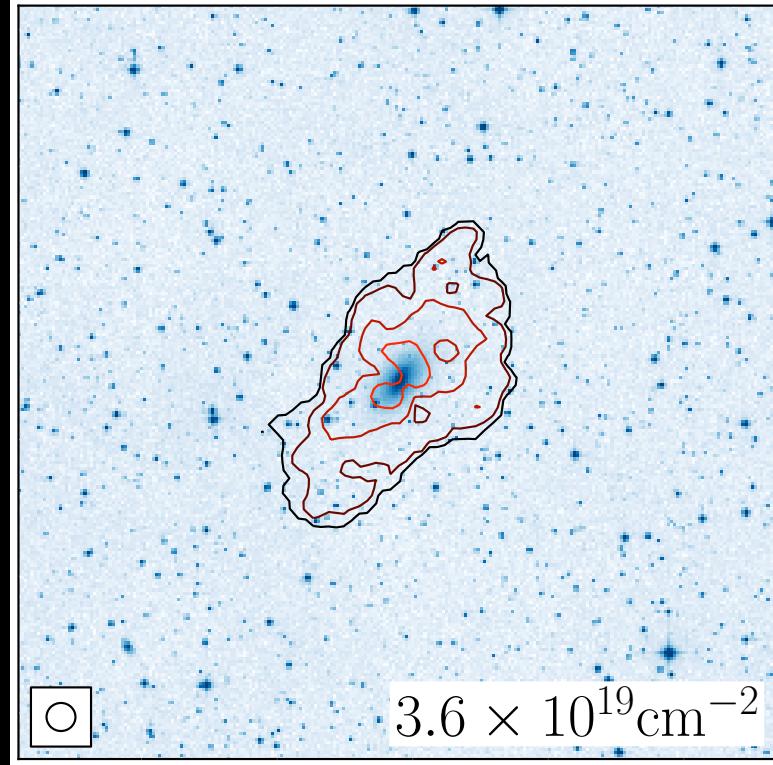
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Large HI discs/rings (18% of all ETGs outside Virgo)

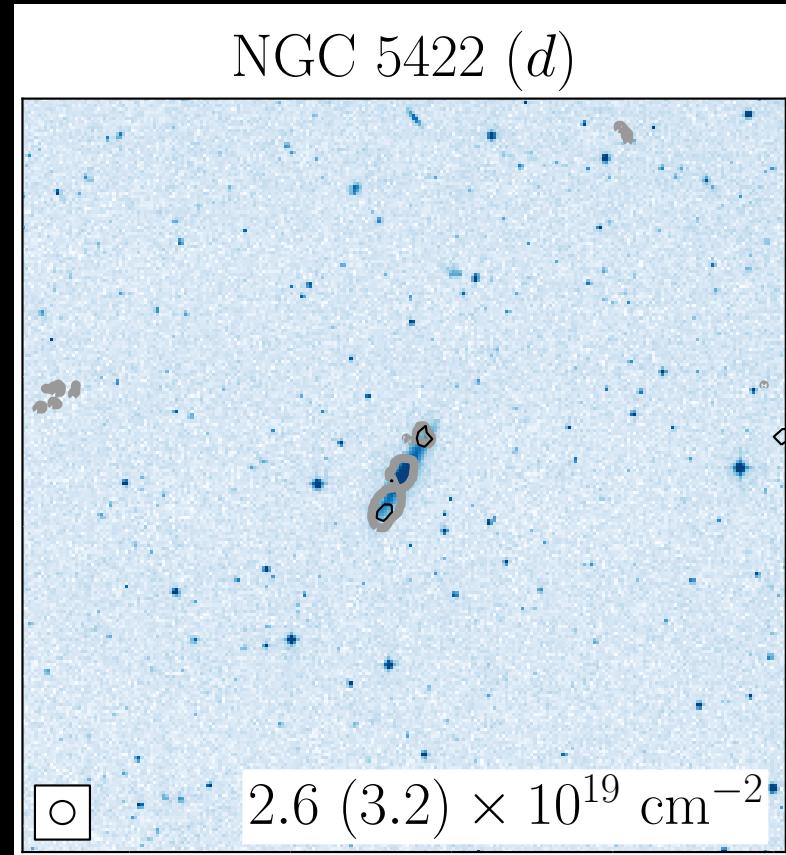
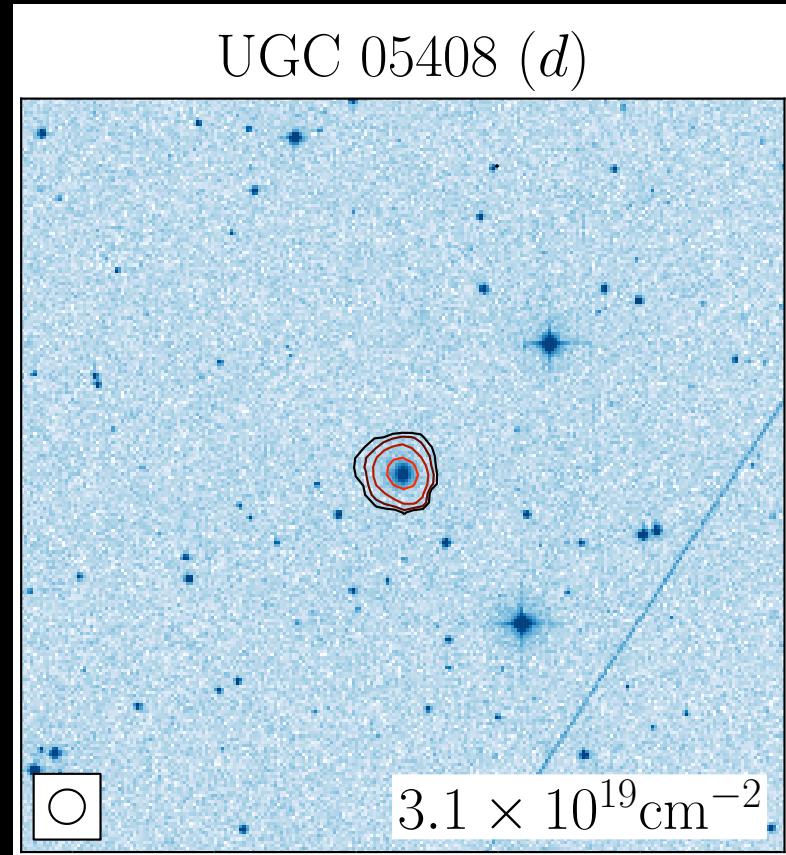
NGC 5582 (*D*)



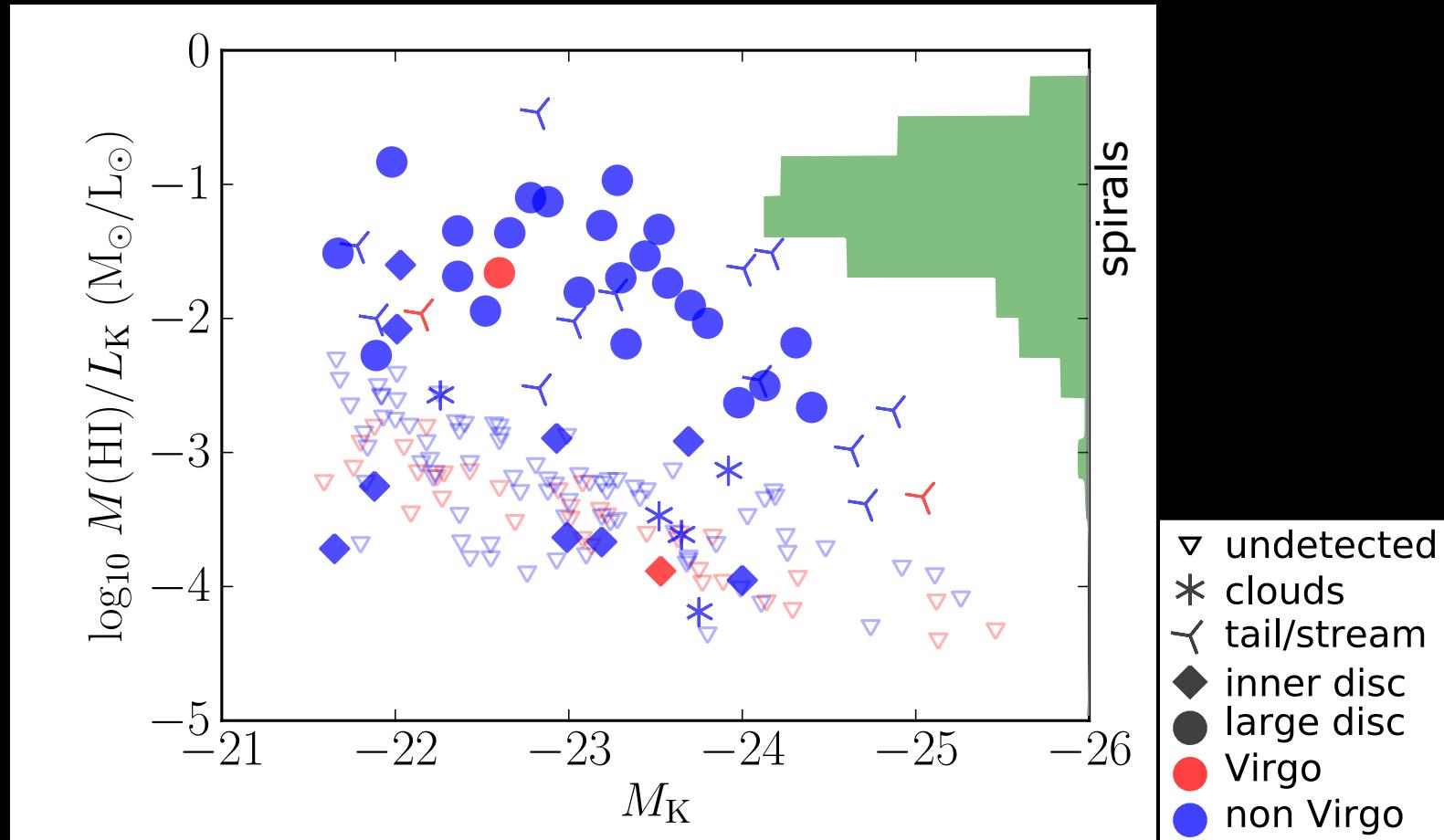
NGC 6798 (*D*)



Small HI discs (7% of all ETGs outside Virgo)

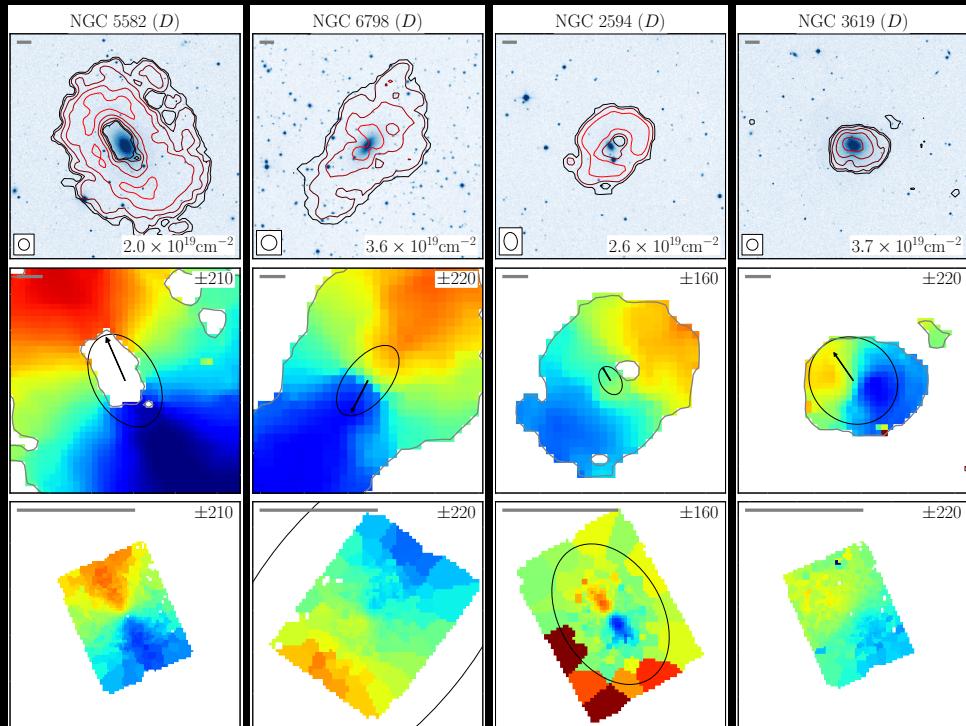


What is the difference between ETGs and spirals?

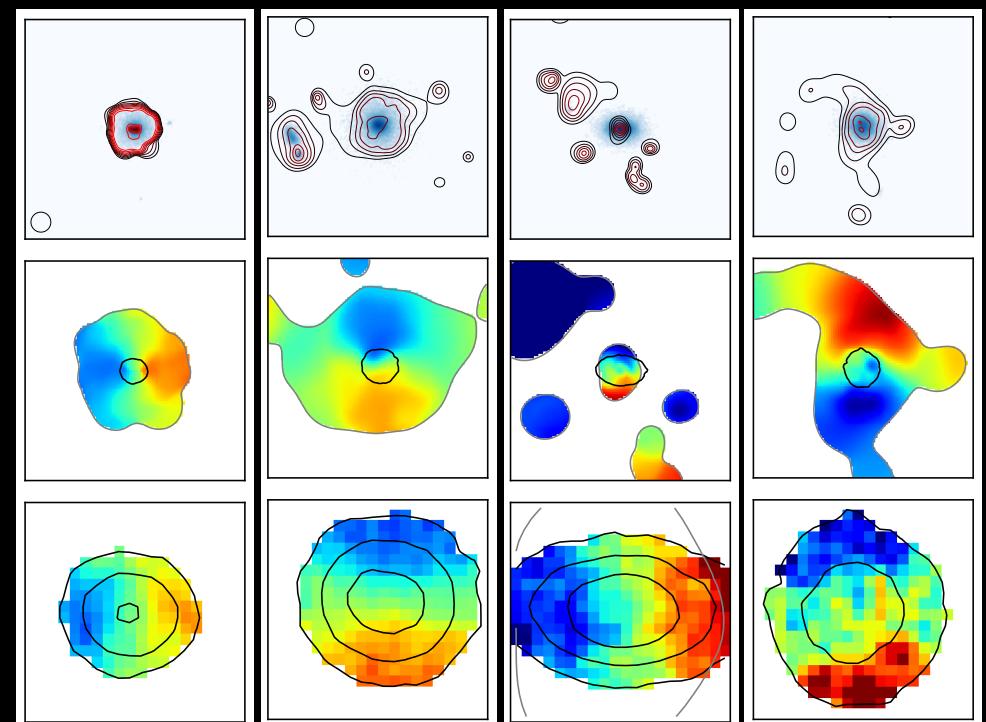


Comparison to cosmological simulations

Observed galaxies



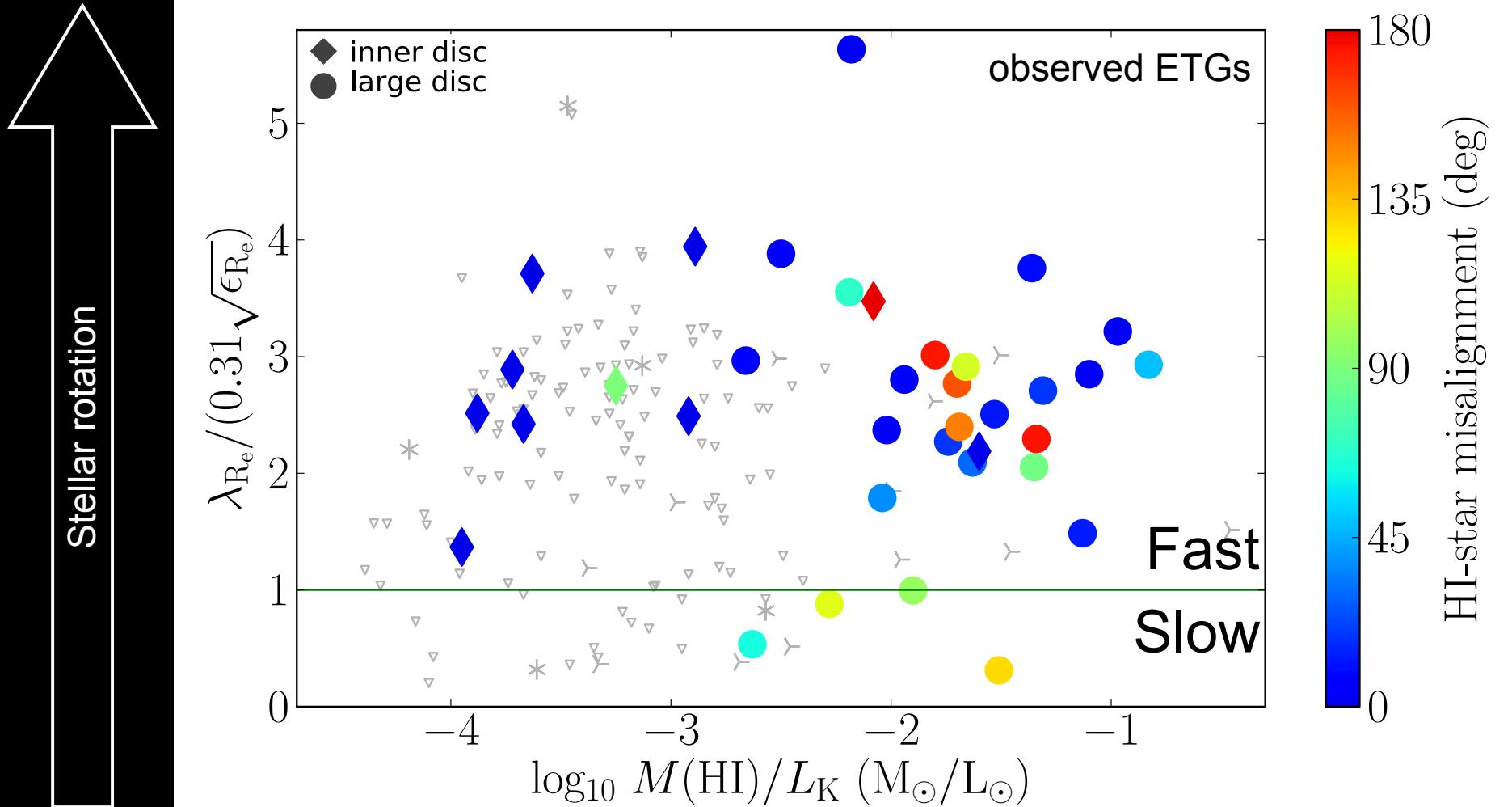
Simulated galaxies (Naab, Oser et al.)



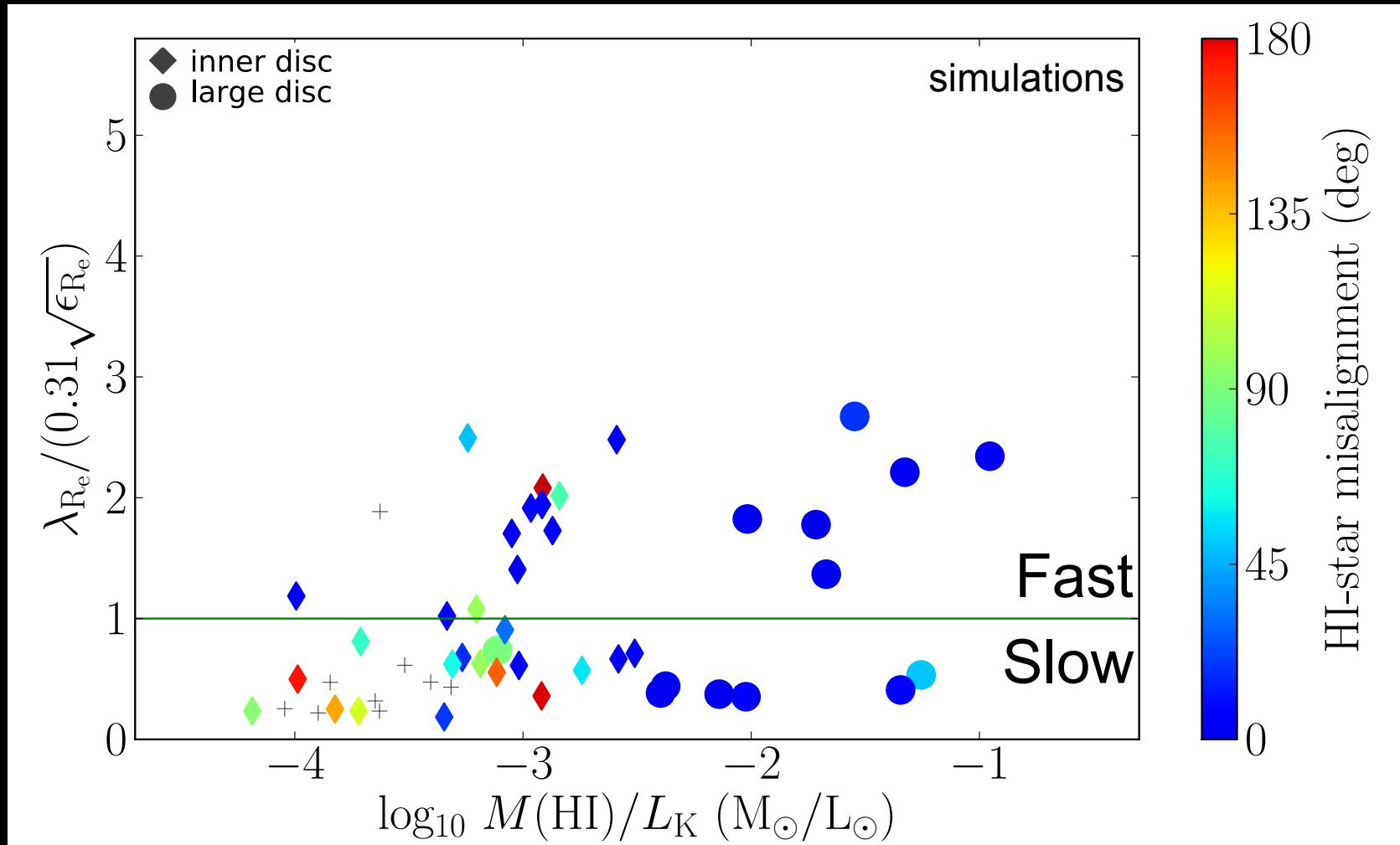
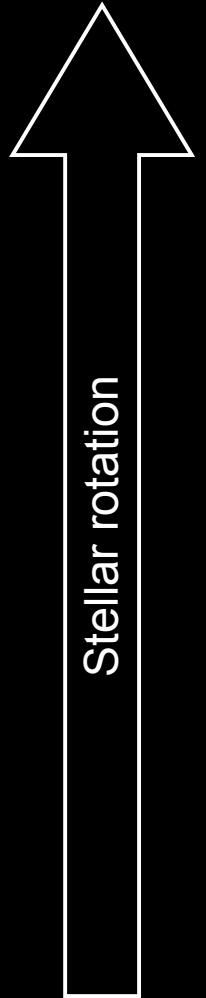
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A challenge to simulations



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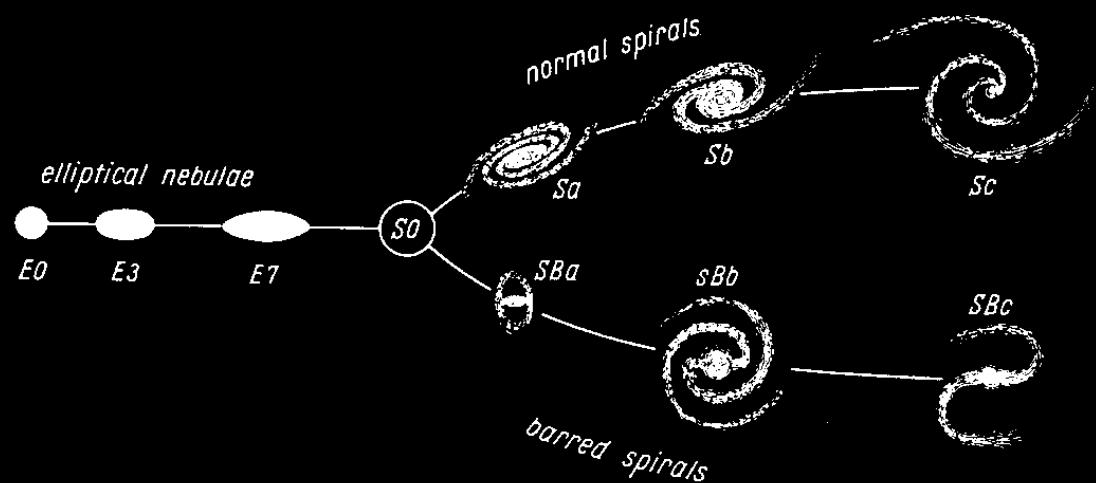


- HI in 40% of all ETGs outside Virgo. HI discs in ~25%.
- Difference from spirals: 1) low $M(\text{HI})$; 2) low HI surface density.
- HI kinematical misalignments challenge simulations.



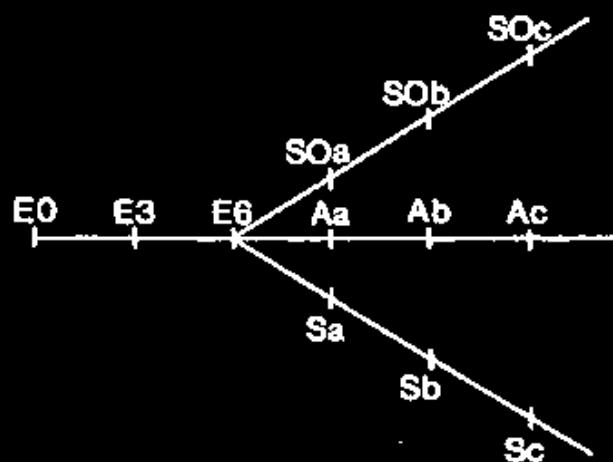
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Cold gas in ETGs – why care?



Hubble (1936)

Kormendy & Bender (1996)



van den Bergh (1976)

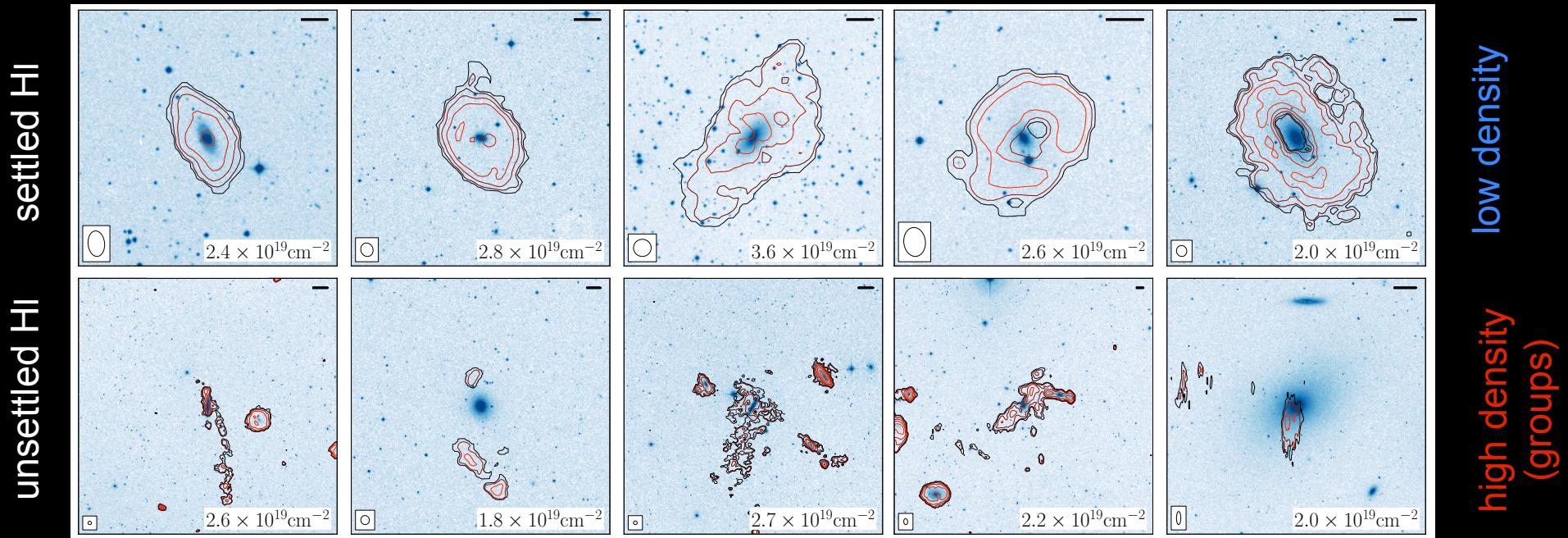
Cappellari et al. (2011)

Kormendy & Bender (2012)

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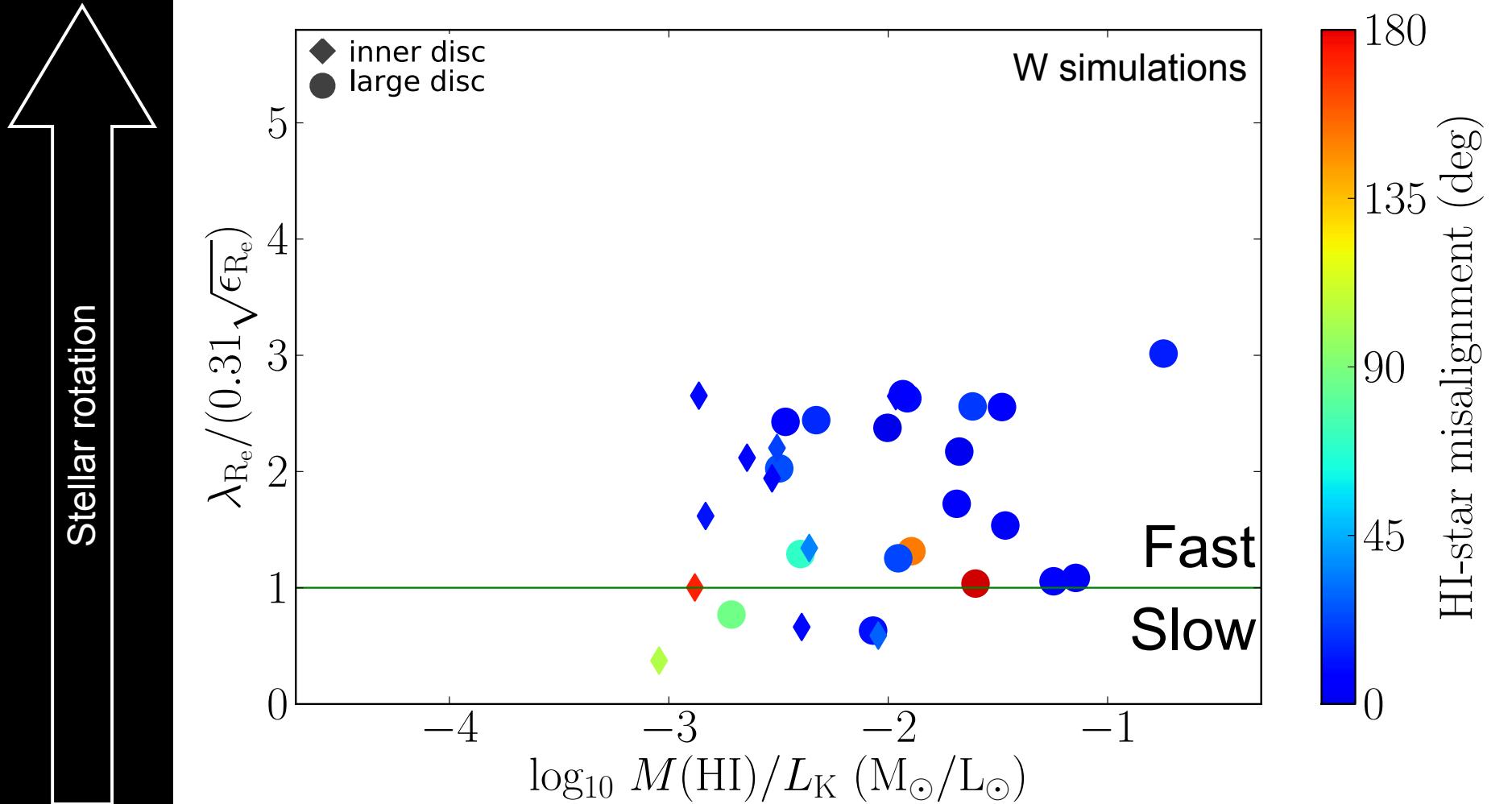
Atlas^{3D} HI survey: the importance of environment

166 early-type galaxies, ~ 2000 h Westerbork
 sensitivity: $N(\text{HI}) \sim 10^{19} \text{ cm}^{-2}$, $M(\text{HI}) \sim 10^7 M_\odot$
 40% det. rate outside Virgo
 1/4 of all ETGs host HI discs (10^7 - $10^{10} M_\odot$)





A challenge to simulations



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