

The origin of thick discs

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Abstract. Thick discs are defined to be disc-like components with a scale height larger than that of the classical discs. They are ubiquitous (Yoachim & Dalcanton 2006; Comerón *et al.* 2011a), they are made of mostly old and metal-poor stars and are most easily detected in close to edge-on galaxies. Their origin has been considered mysterious and several formation theories have been proposed:

- The thick disc being formed secularly by thin disc stars heated by disc overdensities such as giant molecular clouds or spiral arms (Villumsen 1985, *ApJ*, 290, 75) and by stars moved outwards from their original orbits by radial migration mechanisms (Schönrich & Binney 2009).
- The thick disc being formed by the heating of the thin disc by satellites (Quinn *et al.* 1993) and the tidal stripping of them (Abadi *et al.* 2003).
- The thick disc being formed fast and already thick at high redshift in an highly unstable disc. Inside that thick disc, a thin disc would form afterwards as suggested by Elmegreen & Elmegreen (2006).
- The thick disc being formed originally thick at high redshift by the merger of gas-rich protogalactic fragments and a thin disc forming afterwards within it (Brook *et al.* 2007).

The first mechanism is a secular evolution mechanism. The time-scale of the second one is dependent on the merger history of the main galaxy. In the two last mechanisms, the thick disc forms already thick in a short time-scale at high redshift.

Recent Milky Way studies, (see, e.g., Bovy *et al.* 2012), have shown indications that there is no discontinuity between the thin and the thick disc chemical and kinematic properties. Instead, those studies indicate the presence of a monotonic distribution of disc thicknesses. This would suggest a secular origin for the Milky Way thick disc.

Studies in external galaxies (Yoachim & Dalcanton 2006; Comerón *et al.* 2011b), have shown that low-mass disc galaxies have thick disc relative masses much larger than those found in large-mass galaxies. Because low-mass galaxies are dynamically younger than their larger counterparts, it seems difficult for their thick discs to have a secular evolution origin, but simulations show that their thick disc masses are compatible with those of a thick disc formed at high redshift.

Thus, recent studies seem to indicate that large-mass galaxies have their thick discs formed mainly due to secular evolution and that low-mass galaxies have them formed at high redshift.

Keywords. galaxies: evolution – galaxies: formation – galaxies: kinematics and dynamics

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