On the origin of the Galactic thin and thick disks, their abundance gradients and the diagnostic potential of their abundance ratios

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Using a semi-analytical model of the evolution of the Milky Way, we show how secular evolution can create distinct overdensities in the phase space of various properties (e.g. age vs metallicity or abundance ratios vs age) corresponding to the thin and thick disks. In particular, we show how key properties of the solar vicinity can be obtained by secular evolution, with no need for external or special events, like galaxy mergers or paucity in star formation. This concerns the long established double-branch behavior of [alpha/Fe] vs metallicity and the recently found non-monotonic evolution of the stellar abundance gradient, evaluated at the birth radii of stars. We extend the discussion to other abundance ratios and we suggest a classification scheme, based on the nature of the corresponding yields (primary vs secondary or odd elements) and on the lifetimes of their sources (short-lived vs long-lived ones). The latter property is critical in determining the single- or double- branch behavior of an elementary abundance ratio in the solar neighborhood. We underline the high diagnostic potential of this finding, which can help to separate clearly elements with sources evolving on different timescales and help determining the site of e.g. the r-process(es).

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