Title: Analytic solution of chemical evolution models with Type Ia supernovae.

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Abstract:

In recent years, a significant number of works have focused on finding analytic solutions for the chemical enrichment models of galactic systems, including the Milky Way. However, some of these solutions are unable to account for the enrichment produced by Type Ia supernovae (SNe) due to the presence of delay time distributions (DTDs) in the models. In general, the additional term associated with the DTD makes finding the analytical solution of the model equations very difficult or even impossible. In Palicio et al. (2023b), we provide an analytic solution for a chemical evolution model that incorporates the contribution of iron produced by Type Ia SNe. This solution can be applied with various prescriptions of the DTD, including single- and double-degenerate scenarios, and allows for the incorporation of an arbitrary number of pristine gas infalls. For those DTDs resulting in non-analytic integrals, we describe them as a superposition of Gaussian, exponential, and 1/t functions using a restricted least-squares fitting method. As a result, we can reproduce the expected chemical evolution of alpha and iron-peak elements in less computing time than numerical integration methods. We illustrate this by comparing the pattern observed in the [Si/Fe] versus [Fe/H] plane in APOGEE DR17 data with that predicted by the model. We find that the low alpha sequence can be explained by delayed gas infall, as suggested in previous works. We demonstrate the applicability of our solution by modeling the chemical evolution of a simulated Milky Way-like galaxy, generated without chemical information, based on its star formation history. Our analytic solution has been implemented in the Python module ChEAP, which is publicly available for the community.

References:

Palicio et al. (2023b): https://ui.adsabs.harvard.edu/abs/2023A%26A...678A..61P/abstract

ChEAP repository: https://bitbucket.org/pedroap/cheap