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TITLE: Oxygen to argon abundance ratios for planetary nebulae and HII regions : how to constrain the chemical enrichment of the thin and thicker discs of Andromeda
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ABSTRACT:
We use oxygen and argon abundances for planetary nebulae (PNe) with low internal extinction (progenitor ages of > 4.5 Gyr) and high extinction (progenitor ages < 2.5 Gyr), as well as those of the HII regions, to constrain the chemical enrichment and star formation efficiency in the thin and thicker discs of M31. The argon element is produced in larger fractions by Type Ia supernovae compared to oxygen. We find that the mean log(O/Ar) values of PNe as a function of their argon abundances, 12 + log(Ar/H), trace the interstellar medium (ISM) conditions at the time of birth of the M31 disc PN progenitors. Thus, the chemical enrichment and star formation efficiency information encoded in the [α/Fe] versus [Fe/H] distribution of stars is also imprinted in the oxygen-to-argon abundance ratio log(O/Ar) versus argon abundance for the nebular emissions of the different stellar evolution phases. We propose using the log(O/Ar) versus (12 + log(Ar/H)) distribution of PNe with different ages to constrain the star formation histories of the parent stellar populations in the thin and thicker M31 discs. Diagrams for M31 PNe in different age ranges reveal that a secondary infall of gas affected the chemical evolution of the M31 thin disc. In M31, the thin disc is younger and less radially extended, formed stars at a higher star formation efficiency, and had a faster chemical enrichment timescale than the more extended thicker disc.