Constraining positron emission from pulsar populations with AMS-02 data

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The observation of high-energetic cosmic-ray positrons with unprecedented precision by AMS-02 suggests the presence of primary positron (e^+) sources in our Galaxy, as the observed flux exceeds the so-called secondary flux produced by inelastic collisions of cosmic-ray nuclei in the interstellar medium above about 10 GeV. Pulsars have been consolidating as significant factories of high-energy cosmic-ray electrons and positrons ($e^\pm$) in the Galaxy, and thus as main candidates to explain the e^+ excess. The observation of γ-ray halos at TeV energies of a few degree size around two nearby pulsars (Geminga and Monogem) corroborates the presence of $e^\pm$ accelerated, and escaped, by their PWNe since the observed emission is interpreted as generated by the $e^\pm$ escaping from the PWNe system and inverse Compton scattering low-energy photons of the interstellar radiation fields. Current source catalogs might be not complete and thus simulations of the pulsar populations are needed to extensively test the pulsar interpretation of the observed e^+ flux. The idea of this work is to use the existing high-precision e^+ data to constrain the main properties of the Galactic pulsar population and of the PWN acceleration needed to explain the observed cosmic-ray fluxes. We here simulate a large number of realizations for Galactic pulsar populations, comparing different updated models which reproduce ATNF catalog observations, instead of ad-hoc realization of pulsar characteristics. For each mock galaxy, we compute the resulting cosmic-ray e^+ flux at the Earth from the PWN population and we fit it to the AMS-02 data to determine the physical parameters of these populations and of individual sources, which are able to explain the observede^+ flux. We find that several mock galaxies have a pulsar population able to explain the observed e^+ flux, typically characterized by few, bright sources with ages between 400 and 2000 kyr and distances<3 kpc. We determine the physical parameters of the sources dominating the e^+ flux, and assess the impact of different assumptions on radial distributions, spin-down properties and propagation scenarios.

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