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Cosmic ray positrons: constraints on propagation parameters and dark matter searches in view of AMS-02 data

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Two years ago, the AMS collaboration released the most precise measurement of the cosmic ray positron flux. It confirms that pure secondary predictions fall below the data above 10 GeV, suggesting the presence of a primary component, e.g. annihilations of WIMPs dark matter. Most analyses have focused on the high-energy part of the spectrum, disregarding the GeV energy region where cosmic ray transport is harder to model and solar modulation comes into play. Given the high quality of AMS measurements, we re-examine the positron anomaly over the entire energy range, taking into account transport processes so far neglected, e.g. convection or diffusive re-acceleration. We devise a new semi-analytical method to take into account transport processes so far neglected, but important below a few GeV. It is based on the pinching of inverse Compton and synchrotron energy losses inside the Galactic disc. It allows to carry out extensive scans over the cosmic ray propagation parameters, which we strongly constrain by requiring that the secondary component does not overshoot the AMS measurements. Only models with large diffusion coefficients survive this test. The positron flux is a powerful and independent probe of cosmic ray propagation, complementary to the boron-to-carbon ratio. We then scan over WIMP mass to fit the annihilation cross section and branching ratios, exploring both direct annihilations into standard model particles or through light mediators. In the former case, the best fit yields a p-value of 0.4% for a mass of 264 GeV, a value that does not allow to reproduce the highest energy data points. Worse quality fits are found in the latter case. The interpretation of the positron excess in terms of single DM species annihilations is strongly disfavored. This conclusion is based solely on the positron data, and no other observation needs to be invoked.

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