

Exercise to the Lecture Astroparticle Physics KIT, Wintersemester 2023/24

Prof. G. Drexlin, S. Mohanty, J. Storek, N. Gutknecht



Lectures	Thur. 14:00 + Wed 14:00 (every 14 days), Phys-HS Nr. 3
Exercises	Wed 14:00 (alternating with lecture), Phys-HS Nr. 3
ILIAS	https://ilias.studium.kit.edu/goto.php?target=fold_2238589&client_id=produktiv

Sheet 4 – Due 10.01.2024

contact for sheet 4: nathanael.gutknecht@student.kit.edu

1) **Dark Matter: Overview** (2.5 + 2.5 + 2.5 = 7.5 points)

Create a short summary/overview for the following questions:

- (a) What evidence is there for dark matter?
- (b) Which three approaches are used in search for dark matter particles?
- (c) What candidates have been proposed for dark matter? How do these types differ?

2) **Indirect Search for Dark Matter** (2.5 + 2.5 + 2.5 = 7.5 points)

Read the proceeding “INDIRECT DARK MATTER SEARCHES IN THE LIGHT OF THE RECENT AMS-02 OBSERVATION” (<https://doi.org/10.48550/arXiv.1605.01218>) and answer the following questions:

(a) Introduction:

- What do the measurements by the Planck satellite suggest?
- Which particle does the proceeding favor as a dark matter particle?
- Which secondary particles are mainly searched for in the indirect detection of dark matter?

(b) Positron Excess:

- Which excess have PAMELA and AMS-02 shown?
- Why is this excess of interest?
- What is the range of high-energy positrons affected by?
- The data was fitted with a dark matter annihilation model. What is the result for the annihilation cross section? Does the fitted value correspond to the expected value?
- What is an alternative explanation for the positron excess?

(c) Antiproton Signal:

- Why is the antiproton flux possibly more suitable for the indirect dark matter search than positrons?
- How are antiprotons mainly generated (astrophysical processes)?
- How does the measured ratio of the antiproton flux over the proton flux compare to the expected background level?