


# AXEL WIDMARK

## Physicist & Astronomer

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📍 Dark Cosmology Centre, Niels Bohr Institute, University of Copenhagen  
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## EMPLOYMENT & EDUCATION

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### DARK-Carlsberg Foundation Fellow

#### Dark Cosmology Centre, Niels Bohr Institute (NBI), Copenhagen University

📅 01-09-2020 – 31-08-2023    📍 Copenhagen, Denmark

Employed as a post-doctoral researcher pursuing independent research

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### PhD in theoretical physics

#### Physics Department, Stockholm University (SU)

📅 05-09-2016 – 31-08-2020    📍 Stockholm, Sweden

Title of dissertation: *Dark Matter in the Solar System, Galaxy, and Beyond*

PhD defence and award dates: 25-05-2020, 18-06-2020

Supervisor: Jens Jasche, jens.jasche@fysik.su.se

Assistant supervisor: Joakim Edsjö, edsjo@fysik.su.se

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### MSc Physics and Astronomy; BSc Engineering Physics

#### Chalmers University

📅 2011 – 2016    📍 Gothenburg, Sweden

Master's Thesis: *Dark Matter Capture by the Sun via Self-Interaction*

Supervisor: Riccardo Catena, riccardo.catena@chalmers.se

Exchange studies, EPFL Lausanne, Switzerland, two semesters (fall 2014, spring 2015)

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## COLLABORATIVE VISITS & STIPENDS

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### Institut de Ciències del Cosmos, Universitat de Barcelona (ICCUB)

(20-06-2022 – 24-06-2022)

I was invited to spend a week with the researchers at ICCUB, e.g. Chervin Laporte, Teresa Antoja, Friedrich Anders.

### Center for Cosmology and Particle Physics (CCAPP), Ohio State University

(10-01-2022 – 14-01-2022)

I was invited and locally sponsored to visit CCAPP for one week, meeting with John Beacom, Annika Peter, Jennifer Johnson, etc.

### Center for Computational Astrophysics (CCA), Flatiron Institute

(17-01-2022 – 21-01-2022)

I was invited and locally sponsored to visit CCA for one week, to meet with the dynamics group, e.g. Jason Hunt, Kathryn V. Johnston, Sarah Pearson.

**Center for Cosmology and Particle Physics (CCAPP), Ohio State University**  
(12-08-2019 – 16-08-2019)

I visited CCAPP for one week, working mainly with John Beacom and Tim Linden. This visit was sponsored by the Cosmology and Astroparticle Student and Postdoc Exchange Network (CASPEN) and a travel stipend from Kyltekniska fonden.

**University College London**  
(23-04-2018 – 04-05-2018)

I visited University College London for two weeks, sponsored by CASPEN.

**Center for Computational Astrophysics (CCA), Flatiron Institute**  
(18-09-2017 – 30-09-2017)

I visited CCA for two weeks, working with David W. Hogg and Boris Leistedt, sponsored by CASPEN.

## ACADEMIC SERVICE & AWARDS

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### Referee

- Monthly Notices of the Royal Astronomical Society (MNRAS)
- Journal of Cosmology and Astroparticle Physics (JCAP)
- The Astrophysical Journal (ApJ)
- OPTICON telescope access programme



### Invited author

Snowmass2021 Cosmic Frontier White Paper: Dark Matter Physics from Halo Measurements



### Winner of the Astrostatistics Student Paper Competition

The competition was sponsored by the Astrostatistics Interest Group of the American Statistical Association. It took place at the Joint Statistical Meetings of August 2019 in Denver, Colorado.



### Interest group organization

**At NBI:** I initiated the **Data Mining Club** and organize its bi-weekly meetings (2021–ongoing)

**At SU:** I initiated the **Gaia Working Group** and organized its weekly meetings (2019–2020)



### Teaching

**At NBI:** Teacher in the course *Galactic Dynamics and Galaxy Formation*; successful supervision of a Master's project, as well as an ongoing project with a PhD student

**At SU:** Teaching assistant in courses *Thermodynamics* and *Cosmology and Astroparticle Physics*, and administrative responsibilities for course evaluations

**At Chalmers:** Teaching assistant for the Mathematics Department



### Public outreach

**At NBI:** Participated in “Bestil en Forsker” (“Order a scientist”)

**At SU:** Science presentations for local high school classes over three years

# SELECTED PRESENTATIONS

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## Presentations on weighing the Galactic disk using phase-space spirals

- 22-06-2022 **Invited** seminar at Institut de Ciències del Cosmos, Universitat de Barcelona (Barcelona, Spain)
- 05-05-2022 **Invited** Astrophysics Seminar at the University of Surrey (remote, Surrey, England)
- 29-03-2022 **Invited** Galaxy Group Meeting seminar at MPIA (remote, Heidelberg, Germany)
- 20-01-2022 **Invited** presentation with the Dynamics Group at Flatiron Institute (New York, USA)
- 27-10-2021 **Invited** seminar at King's College (remote, London, England)
- 26-10-2021 **Invited** seminar at CCAPP, Ohio State University (remote, Columbus, USA)
- 28-09-2021 **Invited** Astronomy Seminar at Queen's University (remote, Kingston, Canada)
- 20-09-2021 **Invited** seminar with the Gaia interest group (remote, Cambridge, England)
- 09-09-2021 **Invited** seminar at the Kapteyn Astronomical Institute (remote, Groningen, Netherlands)
- 23-06-2021 **Invited** seminar at Harvard's Particle Theory Journal Club (remote, Cambridge, USA)
- 22-06-2021 **Invited** MPA Cosmology Seminar (remote, Munich, Germany)
- 04-06-2021 **Invited** seminar at Observatoire de Strasbourg (remote, Strasbourg, France)

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## Other

- 29-01-2021 **Invited** seminar with the Gaia interest group (remote, Cambridge, England)
- 03-09-2019 Gaia Treasure Hunt conference (Cambridge, England)
- 12-08-2019 CCAPP Summer Lecture Series, Ohio State University (Columbus, USA)
- 30-07-2019 Joint Statistical Meetings (Denver, USA)
- 19-12-2018 Annual Paris-Amsterdam-London-Stockholm meeting (December 2018, London, England)
- 03-05-2018 Dark Matter Forum, Imperial College London and King's College London (London, England)
- 03-04-2018 University College London (April 2018, London, England)

# PUBLICATIONS

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- [1] A. Widmark, M. Korsmeier and T. Linden, *Weighing the Local Interstellar Medium using Gamma Rays and Dust*, arXiv:2208.11704, submitted to PRL.
- [2] A. Widmark, L.M. Widrow and A. Naik, *Mapping Milky Way disk perturbations in stellar number density and vertical velocity using Gaia DR3*, arXiv:2207.03492, accepted for publication in A&A.
- [3] A. Naik and A. Widmark, *The missing radial velocities of Gaia: blind predictions for DR3*, MNRAS **516** (2022) 3.
- [4] K. Bechtol et al., *Snowmass2021 Cosmic Frontier White Paper: Dark Matter Physics from Halo Measurements*, arXiv:2203.07354.
- [5] A. Widmark, J.A.S. Hunt, C.F. Laporte and G. Monari, *Weighing the Galactic disk using phase-space spirals IV. Tests on a three-dimensional galaxy simulation*, A&A **663** (2022) A16.
- [6] A. Widmark, C.F. Laporte, P.F. de Salas and G. Monari, *Weighing the Galactic disk using phase-space spirals III. Probing distant regions of the disk using the Gaia EDR3 proper motion sample*, A&A **663** (2022) A15.
- [7] S. Sivertsson et al., *Estimating the local dark matter density in a non-axisymmetric wobbling disc*, MNRAS **511** (2022) 2.
- [8] P.F. de Salas and A. Widmark, *Dark matter local density determination: recent observations and future prospects*, Rep. Prog. Phys. **84** (2021) 104901.
- [9] A. Widmark, C.F. Laporte, P.F. de Salas and G. Monari, *Weighing the Galactic disk using phase-space spirals II. Most stringent constraints to a thin dark disk using Gaia EDR3*, A&A **653** (2021) A86.
- [10] A. Widmark, C.F. Laporte and P.F. de Salas, *Weighing the Galactic disk using phase-space spirals I. Tests on one-dimensional simulations*, A&A **650** (2021) A124.
- [11] A. Widmark, P.F. de Salas and G. Monari, *Weighing the Galactic disk in sub-regions of the solar neighbourhood using Gaia DR2*, A&A **646** (2021) A67.
- [12] A. Widmark, K. Malhan, P.F. de Salas and S. Sivertsson, *Measuring the matter density of the Galactic disc using stellar streams*, MNRAS **496** (2020) 3.
- [13] A. Widmark, *21 cm cosmology and spin temperature reduction via spin-dependent dark matter interactions*, JCAP **1906** (2019) 014.
- [14] A. Widmark, *Measuring the local matter density using Gaia DR2*, A&A **623** (2019) A30.
- [15] A. Widmark, D. Mortlock and H.V. Peiris, *Inferring properties of the local white dwarf population in astrometric and photometric surveys*, MNRAS **485** (2019) 1.
- [16] A. Widmark and G. Monari, *The dynamical matter density in the solar neighbourhood inferred from Gaia DR1*, MNRAS **482** (2019) 1.

- [17] A. Widmark, B. Leistedt and D.W. Hogg, *Inferring binary and trinary stellar populations in photometric and astrometric surveys*, *ApJ* **857** (2018) 2.
- [18] A. Widmark, *Thermalization time scales for WIMP capture by the Sun in effective theories*, *JCAP* **1705** (2017) 046.
- [19] R. Catena and A. Widmark, *WIMP capture by the Sun in the effective theory of dark matter self-interactions*, *JCAP* **1612** (2016) 016.
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 **Public code**      [github.com/axelwidmark](https://github.com/axelwidmark)

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These publications cover different fields in physics, including the phenomenology of dark matter capture by the Sun, 21 cm cosmology,  $\gamma$ -ray analysis, stellar dynamics, and astrostatistics. In a series of four first-author papers [5,6,9,10], we develop, test, and apply a completely novel method for weighing the Milky Way disk, using the non-equilibrium dynamical structure of the phase-space spiral.