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Winds of stars and exoplanets

De Almeida Vidotto, A.; Fossati, L.; Vink, J.S.

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Winds of Stars and Exoplanets

Edited by

Aline A. Vidotto

Luca Fossati

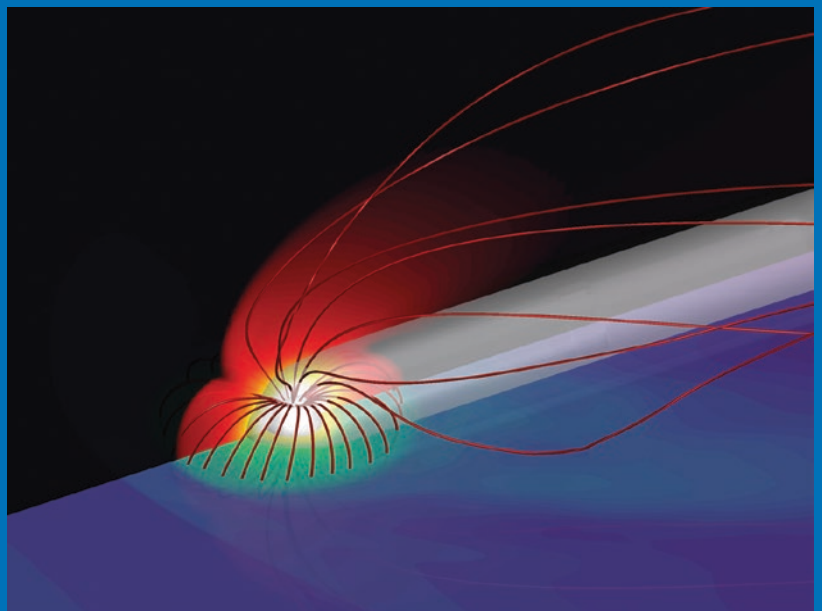
Jorick S. Vink

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COVER ILLUSTRATION:

Three-dimensional simulation of the escaping atmosphere of a close-in exoplanet interacting with the wind of its host star. The red field lines represent the planetary magnetic field, while the contours represent the total density (horizontal plane) and the neutral hydrogen density (vertical plane). Figure from Carolan et al 2021.

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Chief Editor

JOSÉ MIGUEL RODRIGUEZ ESPINOSA, General Secretariat

Instituto de Astrofísica de Andalucía

Glorieta de la Astronomía s/n

18008 Granada

Spain

IAU-general.secretary@iap.fr

Editor

DIANA WORRALL, Assistant General Secretary

HH Wills Physics Laboratory

University of Bristol

Tyndall Avenue

Bristol

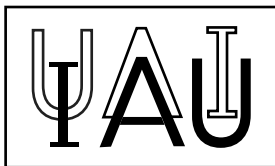
BS8 1TL

UK

IAU-assistant.general.secretary@iap.fr

INTERNATIONAL ASTRONOMICAL UNION
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WINDS OF STARS AND EXOPLANETS

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8–11 AUGUST 2022

Edited by

ALINE A. VIDOTTO

Leiden Observatory, Leiden University, the Netherlands

LUCA FOSSATI

Space Research Institute, Austrian Academy of Sciences, Austria

and

JORICK S. VINK

Armagh Observatory and Planetarium, Armagh, N. Ireland, UK



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Preface

Winds form an integral part of astronomy – from regulating rotation of stars through enriching galaxies with fresh materials, outflowing winds persist during the entire lives of stars and play a key role in shaping the observed exoplanet demographics. In the case of massive stars, their winds are a vital ingredient of their evolution, from the main sequence to the pre-supernova stage, determining black hole masses as measured from gravitational waves. In the case of low-mass stars, their winds dictate rotational evolution, which affect angular momentum distribution within the stellar interior and thus affect generation of magnetic fields. Finally, in the case of planets, winds take the form of atmospheric escape, which can strongly affect their atmospheric evolution. Strong escape of highly irradiated exoplanets have now been observed in several close-in exoplanets during transits and are indirectly detected in the observed exoplanet radius distribution.

Although the only astrophysical wind that we are able to directly probe is that of the Sun, the past decades have seen great progress in observing winds of other astrophysical objects. In particular, in recent years, several observing programmes and space missions have focused on studying winds from our Sun, other stars and exoplanets.

On the solar side, two new space missions, Parker Solar Probe and Solar Orbiter, are dedicated to studying the physics of the solar wind. By traveling much closer to the Sun than any other spacecraft has ever been, these new missions allow direct measurements of the solar wind at an unprecedented close distance. Data from these missions might provide interesting implications for the variability of the plasma environment at the orbits of close-in exoplanets.

On the stellar side, winds of low-mass stars are magnetically driven, and magnetism has been either directly (through Zeeman effects) or indirectly (through activity proxies) observed in these stars. Recently, many new magnetospheres were detected around massive stars as well. In spite of similarities, there is a major difference between winds of low- and high-mass stars: their mass-loss rates are orders of magnitude different, due to different physical processes driving their winds. Even with substantially lower mass loss rates, winds of low mass-stars play a fundamental role in removing angular momentum, and thus, shaping the rotational evolution of these stars.

On the planetary side, missions like Kepler, TESS and Plato (will) provide the statistics for planet population studies and hence infer the indirect presence of outflowing planetary winds in shaping the distribution of sizes of close-in exoplanets. HST has been fundamental in detecting strong atmospheric escape of close-in giant planets through ultraviolet transmission spectroscopy. Recent observations have also opened the possibility to detect escaping planetary winds from the ground.

In order to gain insight in the physics and the modelling tools used by different communities, and to foster communication between communities that do not usually interact with each other, we brought together researchers working on winds of close-in exoplanets (atmospheric escape), winds of low- and high-mass stars and the solar wind in a symposium dedicated to “winds”. The IAU Symposium “S370: Winds of stars and exoplanets”, that took place in Busan, Republic of Korea, from 8 to 11 August 2022.

In this book, you will find contributions from most of the symposium presenters. The first Part presents an overview of winds of stars and planets, introducing its similarities and differences. The remaining parts contain the four main themes discussed in the symposium

- Observational evidence of winds
- Physical ingredients of winds

- Flow-flow interactions
- Relevance of winds on stellar/planetary evolution

The IAU Symposium 370 took place during the XXXI General Assembly meeting in Busan, in the midst of the Covid-19 global pandemic. We wish to thank the Local Organisation of the General Assembly meeting for their substantial efforts to make it possible that we all could meet in person again. We also warmly thank all the participants of the meeting for their cooperation and understanding during these difficult times.

Aline A. Vidotto
Luca Fossati
Jorick S. Vink

Editors

Aline A. Vidotto
Leiden Observatory, Leiden University, the Netherlands

Luca Fossati
Space Research Institute, Austrian Academy of Sciences, Austria

Jorick S. Vink
Armagh Observatory and Planetarium, Armagh, N. Ireland, UK

Organizing Committee

Scientific Organizing Committee

Aline A. Vidotto (Leiden Observatory, Leiden University, the Netherlands) – **Chair**
Luca Fossati (Space Research Institute, Austrian Academy of Sciences, Austria) – **Co-chair**
Jorick S. Vink (Armagh Observatory and Planetarium, Armagh, UK) – **Co-Chair**
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Takeru Suzuki (University of Tokyo, Japan)

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Junga Hwang, Korea Astronomy & Space Science Institute, Republic of Korea
Ho-Seong Hwang, Seoul National University, Republic of Korea
Chunglee Kim, Ewha Womans University, Republic of Korea
Dohyeong Kim, Pusan National University, Republic of Korea
Ji-hoon Kim, Seoul National University, Republic of Korea
Jongsoo Kim, Korea Astronomy & Space Science Institute, Republic of Korea
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Kang Hwan Lee, Institut Pasteur Korea, Republic of Korea
Sang-Sung Lee, Korea Astronomy & Space Science Institute, Republic of Korea
Seo-gu Lee, Korea Astronomy & Space Science Institute, Republic of Korea
Soo-Chang Rey, Chungnam National University, Republic of Korea
Hyunjin Shim, Kyungpook National University, Republic of Korea
In-Ok Song, Korea Science Academy of KAIST, Republic of Korea
Hong-Jin Yang, Korea Astronomy & Space Science Institute, Republic of Korea
Suk-Jin Yoon, Yonsei University, Republic of Korea
Sung-Chul Yoon, Seoul National University, Republic of Korea

List of Contributors

N. Alameri
A. Allan
M. Alqasimi
J. Alvarado-Gómez
K. Amada
A. Anand
I. Araya
C. Arcos
B. Arora
M. Bernini Peron
A. S. Brun
V. Brunn
T. Cang
S.-J. Chang
J. Chebly
E. Costa-Almeida
M. Cure
S. Daley-Yates
A. Danehkar
J.-M. Desert
L. Dos Santos
F. Driessen
V. Elbakyan
A. Finley
L. Fossati
G. González-Torà
P.-G. Gu
C. Hawcroft
G. Hazra
A. S. Hojaev
A. Ibraimova
H. Imai
A. Javadi
R. Kavanagh
E. Keles
Z. Keszthelyi
H. Kim
K. Kislyakova
V. Kocharovsky
D. Koh
T. Konings
A. Kosherbayeva
D. Kubyshkina
M. Kunitomo
X. Leng
J. Mackey
A. Manchado
A. Manousakis
A. Mehner
C. Meskini
H. Mitani
D. Modirrousta-Galian
N. Moens
T. Moriya
D. Nandi
A. Nanni
D. O Fionnagain
A. Okazaki
R. Osten
S. Owocki
A. Pai Asnodkar
S. Parenti
G. Pinzon
S. Popov
K. Pukitis
V. Ramachandran
A. Ray
M. Saberi
G. N. Sabhahit
A. Sander
I. Shaikhislamov
M. Shoda
A. Strugarek
T. Su
T. Suzuki
A. Taani
G. Telford
O. Verhamme
A. Vidotto
J. Vink
R. Waugh
S.-C. Yoon
S. Yun

