

CHRISTIAN-ALBRECHTS-UNIVERSITÄT ZU KIEL

MASTER THESIS

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# Thesis Title

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Department or School Name

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# Abstract

The Thesis Abstract is written here (and usually kept to just this page). The page is kept centered vertically so can expand into the blank space above the title too...



# Contents

<b>Abstract</b>	<b>iii</b>
<b>1 Motivation</b>	<b>1</b>
<b>2 Pickup Ions</b>	<b>3</b>
2.1 The Heliosphere . . . . .	3
2.2 Pickup Ions . . . . .	3
2.3 Interstellar Pickup Ions . . . . .	4
2.4 Inner-source Pickup Ions . . . . .	4
2.5 VDF . . . . .	4
<b>3 Instrumentation</b>	<b>5</b>
3.1 ULYSSES . . . . .	5
3.2 SWICS . . . . .	5
<b>A Frequently Asked Questions</b>	<b>7</b>
A.1 How do I change the colors of links? . . . . .	7
<b>Bibliography</b>	<b>9</b>
<b>Declaration of Authorship</b>	<b>11</b>
<b>Acknowledgements</b>	<b>13</b>



## Chapter 1

# Motivation





## Chapter 2

# Pickup Ions

Pickup ions are created when neutral atoms inside the heliosphere become ionised and are subsequently swept away with the heliospheric magnetic field that is embedded within the solar wind.

## 2.1 The Heliosphere

Oder Überkapitel Solar Physics?

Heliosphere: Grenze zu LISM

Solar Wind: Zusammensetzung, schneller und langsamer

B-Feldgleichung

## 2.2 Pickup Ions

A neutral atom inside the heliosphere is only subjected to the gravitational force and radiation pressure of the sun. It is not sensitive to any electromagnetic forces until it becomes ionised by solar ultra-violet radiation, charge exchange with solar wind protons or electron impact (Q?). After ionisation the particle starts interacting with the solar wind plasma. In particular it is forced onto a gyro orbit about the heliospheric magnetic field that is embedded within the solar wind. As the freshly created ion is swept away with the magnetic field line it is “picked up” from its location of ionisation – a new pickup ion (PUI) has been created.

PUIs were first observed by Möbius et al. (1985) with the SULEICA Instrument on the AMPTE spacecraft. The particles measured at 1 AU were He<sup>+</sup> ions of interstellar origin.

Once the particle is ionised, its probability to become ionised another time decreases (Quelle). This characteristic of being only singly charged can help to discriminate PUIs from solar wind ions, that are mostly more often charged (Q?).

PUIs are mostly only single charged. This characteristic can help to distinguish them from solar wind ions of coronal origin which often have been ionized multiple times, if not completely. (Q?)

VDF non-maxwellian, spatial density pattern

There have been observed several species of PUIs:

## 2.3 Interstellar Pickup Ions

Heliosheath, relative motion

The neutral part of the LISM can enter the heliosphere as it is not affected by the heliosheath (Todo). Inside the heliosphere the neutrals are guided only by the gravitational force and radiation pressure of the sun. The neutral particle's species determines how deep it can travel into the heliosphere before it becomes ionized. Species with a higher First Ionization Potential will be able to approach the sun much closer without being ionized. This results in He<sup>+</sup> being the dominant PUI species at a solar distance of 1 AU even if in the LISM the abundance of hydrogen is about 10 times the one of helium.

- ionisation process is also dependent of the species
- Spatial distribution:  
gravitational force and radiation pressure lead to two regions of enhanced density of neutrals (in the ecliptic): Focusing cone and crescent. Focusing cone: For species with high FIP (as the others are ionized before and do not reach the downwind side of the sun)
- variation of He<sup>+</sup> with the solar cycle: Rucinski 2003
- H, O and N are depleted in the filtration region (Baranov Malama 1995)
- neutral density determines PUI production rate

## 2.4 Inner-source Pickup Ions

## 2.5 VDF

After the particle has been ionised it is forced onto a gyro motion about the local field line of the heliospheric magnetic field due to the Lorentz force.

No velocity compared to  $v_{sw}$

B field is convected by the SW and moves radially outwards from the sun

Form of the torus depends on several factors: velocity of the particle before the PU process, orientation of the magnetic field

## Chapter 3

# Instrumentation

### 3.1 ULYSSES

sfsf

### 3.2 SWICS

sffsf



## Appendix A

# Frequently Asked Questions

### A.1 How do I change the colors of links?

The color of links can be changed to your liking using:

```
\hypersetup{urlcolor=red}, or  
\hypersetup{citecolor=green}, or  
\hypersetup{allcolor=blue}.
```

If you want to completely hide the links, you can use:

```
\hypersetup{allcolors=.}, or even better:  
\hypersetup{hidelinks}.
```

If you want to have obvious links in the PDF but not the printed text, use:

```
\hypersetup{colorlinks=false}.
```



# Bibliography

Möbius, E., D. Hovestadt, B. Klecker, G. Scholer, and G. Gloeckler (1985). “Direct observation of He<sup>+</sup> pick-up ions of interstellar origin in the solar wind”. In: *nature* 318 (6045), pp. 426–429. DOI: [10 . 1038 / 318426A0](https://doi.org/10.1038/318426A0). URL: <https://www.nature.com/articles/318426a0>.





# Declaration of Authorship

I, Anne Fischer, declare that this thesis titled, and the work presented in it are my own. I confirm that:

- This work was done wholly or mainly while in candidature for a research degree at this University.
- Where any part of this thesis has previously been submitted for a degree or any other qualification at this University or any other institution, this has been clearly stated.
- Where I have consulted the published work of others, this is always clearly attributed.
- Where I have quoted from the work of others, the source is always given. With the exception of such quotations, this thesis is entirely my own work.
- I have acknowledged all main sources of help.
- Where the thesis is based on work done by myself jointly with others, I have made clear exactly what was done by others and what I have contributed myself.

Signed:

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Date:

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# Acknowledgements

The acknowledgments and the people to thank go here, don't forget to include your project advisor...