

How to Write a Research Paper

Sami K. Solanki

with help from:

Dieter Schmitt



and with insignificant modifications by:

Manfred Schüssler

How **NOT** to write a research paper

- Why wait until you have finished your work? Write the paper first and get the results to fit it afterwards.
- Only sissies stick to the truth. Add a bit of artistic licence.
- Your supervisor is MUCH too busy. He/she surely doesn't want to see the paper before submission.
- You have more important things to do than to revise what you have written. Typos? Os hwat?
- Don't english learn! Language total is inimpportant. Publish in Swahili, Malayalam, Rumantsch Grischun

How **NOT** to write a research paper

- Write each thought just as it comes. Forget about structuring the paper.
- Don't waste time trying to explain things. The reader has to know as much as you do about your topic.
- Why be concise (compact)? If instead you can write something that is really verbose, convoluted and describes every tiny little detail again and yet again, so that even the meanest intelligence will know what the paper is about, if they don't give up earlier. In this way you ensure that your paper serves a useful purpose: as a sleeping pill...

How **NOT** to write a research paper

- Use *Italics*, **Bold face**, CAPITALS, Underlining, **Colour**, Size to *highlight* every **second** WORD!!!!!!
- Psssst, keep your units an absolute secret. Better still, don't divulge any numbers at all.
- Use the same symbol, e.g. λ , for at least 3 different quantities, and don't even dream of defining them.
- Don't waste your time looking through the literature. Who cares if other people have published the same results earlier?
- Use extra-small fonts in figures to make sure that nobody can find out what you are plotting.

How **NOT** to write a research paper

- Use a flowery, poetic style. Fill your paper with arabesques of alliteration & marvellous metaphors. The form is important, not the message.
- Use grandiose titles, like “The final truth about planets”, or “Life, the Universe and Everything”. Careful: this last title has already been used.
- Since your work is based on first principles, you need not describe assumptions. There are none.
- Fight publisher terrorism. Disregard prescribed formats.
- Be rude to referees and, if possible, also the editor.
- Never look at the proofs.

How to Write a Research Paper

Without publication, science is dead.

Gerard Piel

Even with publication as described
so far, science is dead anyway.

Sami Solanki

Some basics

- Scientific progress has been the basis of much of the improvement in our standard of living and quality of life. Science has also provided answers to a row of long-standing and deep questions.
- What makes science so strong?
 1. Independence and freedom of research (only within limits for PhD students...)
 2. Open communication of methods, results, data etc. → conferences, seminars, publications
 3. Peer review (refereeing) and critical discussion of results
 4. Repeatability of work and compatibility with other results

Some more basics

- One (maybe the most) important difference between academic & industrial or military research is making your methods and results public:
 - Publication means that results can be openly discussed, tested and compared.
 - ➔ The checks and balances of science require publication. Also, we need to really trust the results we publish.
 - However: Secrecy is often maintained (regarding ideas, techniques, or new results) until published.
- We **must** publish our results, even if we don't like to write. Darwin: "A naturalists life would be a happy one if he had only to observe and never to write."

Yet more basics

- The **number and quality** of publications is an important, possibly the most important factor deciding the career of a scientist, practically a matter of life and death.

→ **Publish or perish!**

- Specifically for our Research School, publication is expected for the successful completion of a thesis.

**Good scientific writing is not a
matter of life and death;
it is much more serious than that.**

Robert Day

Why do we publish?

- to record (archival function of journals),
- to inform peers,
- to educate the next generation of scientists.
- Don't ignore the archival and student audiences: avoid jargon, shorthand explanations, verbose style.

„Simplicity of expression is a natural result of profound thought.“

(Robert A. Day)

Why do I publish?

- Because I want to report new scientific results and get credit.
- Because I need a job, a promotion, or a grant.
- Because I want to achieve social climbing by being visible in ADS/ISI Web of Science, etc.
- Because IMPRS and/or my supervisor regard it as a prerequisite for granting a PhD.

MS's main message...

- Publications are what people eventually see as the result of your scientific work (talks are „teasers“).
- The quality of your work is judged by the quality of your papers.
- Therefore, it is crucial to put every effort into writing good papers: **clarity**, style & form, attractiveness, ...
- Anything sloppy in your papers fires back upon the conscious or subconscious perception of your work:
sloppy paper → sloppy science
- Don't submit a half-baked manuscript: the referee is your most important reader & potential multiplier.

Before starting to write

- Think early about what you want to communicate.
- Identify main aim & message of your paper.
- Wait with writing until you get final or almost final results.
 - But keep a record of your work as you do it. Our memory of even important details is often surprisingly short.
→ “lab notebook”
 - For the same reason start writing a paper soon after getting your results (but not before you have final results)
 - Even if you have “final” results, you will often find that you need to redo some work once you start to write.
- Discuss with your supervisor. He/she can judge best when is the appropriate time to start writing a paper.

Before starting to write

- What kind of publication is it?
Contents, format (& partly style) differ:
 - **Journal paper**: presents final original results, careful description of technique etc., **refereed** ←
 - **Journal “Letter to the Editor”**: short research paper that requires rapid publication (sometimes esteemed higher than regular papers) **refereed** ←
 - **Review paper**: summarizes, evaluates and synthesizes results already published elsewhere.
 - **Proceedings paper**: Often preliminary results, usually short (page limits), sometimes speculative (not as important as a journal paper, e.g. hardly gets cited)
 - **PhD thesis**: Combination of above. E.g.: 1st chapter like review paper, later chapters like journal papers

Note

Non-refereed papers generally are discounted for promotions and job applications.

Before starting to write

- If it is a journal paper, choose the journal (may not be necessary at this stage). However:
 - Implications of possible page limits (e.g., Letters)
 - Implications of format and style requirements (e.g. style of references, B&W or colour)
- Read the literature: Identify what is new in your work relative to what has been done before. Your work must be embedded in what has already been published: each paper is another chapter (or at least a footnote...) in the story of science.
- Well, actually you should have done that at the start and during the research work that you wish now to publish...

Before starting to write

- Put together structure of the paper:
 - Title, authors, addresses, possibly key words, etc.
 - Abstract
 - 1. Introduction
 - 2. Methods & Materials
 - 3. Results and
 - 4. Discussion & Conclusions
 - Acknowledgements
 - References
- IMRaD is a typical structure (AIMRaDAR). In some cases other structures may be more appropriate.
- Divide long sections (e.g. Results) into subsections

Before starting to write

- Select which results to show
 - Often helpful: first choose the figures to be published
 - Criteria: Does the figure show something new? Is it important to understand technique or results?
 - Remember: your interest in the details of your work is larger than that of the reader → be selective!
- Find the order of writing the various parts of the paper that is most natural for you
 - SKS likes to start at Introduction and write through to the end, then add figure captions, references and abstract.
 - M.S. starts with an outline (“skeleton”): section headings, figures, & catchwords. Detailed text, refs., abstract are filled in step by step.

Before starting to write

- Practice and if necessary improve your English!!
 - Remember: A paper is more likely to be read if it can be understood, i.e. if the language is clear.
 - Don't even dream of publishing in another language if you want your work to be noticed.
- You will probably need LaTeX

Time to start!

The Title (“eye contact”)

- The title often decides if the paper is looked at by colleagues: *So many papers, so little time!*
 - I first check the title (& authors). If interesting I look at the abstract, then possibly at the figures & finally at main text.
 - Often used: “Current Contents” only contain titles
- The title should be attractive
- The title should not be too long
- It should reflect the general field of the paper (e.g. include “asteroid” or “solar” or name of body)
- It should be as precise as possible (without forgetting the points above)
- It should not be too grandiose or promise too much

The Title

- Examples of titles. Which are good ones, which ones should you avoid using?
 - **Planetary atmospheres**
(too general) → (e.g.) Turbulence in the atmospheres of terrestrial planets
 - **New light on the heart of darkness of the chromosphere**
("solar" missing) → New light on the heart of darkness of the solar chromosphere (eye-catching, but tricky)
 - **Sizes of spots on sun-like stars**
(fine)
 - **Velocity and temperature in solar magnetic elements from a statistical multi-line centre-to-limb analysis**
(too long, boring) → Centre-to-limb analysis of solar magnetic elements

The Title

- Examples of titles (continued)

- Magnetic fields in late-type dwarfs: Preliminary results of a multi-line approach neglecting line saturation

(too long, too negative) → Magnetic fields in late-type dwarfs measured using a multi-line approach

- Some effects of finite spectral resolution on Stokes V profiles

(does not reveal the main result: absence of downflows)

- The solar iron abundance: the final word

(promised too much. Was followed by paper by another group: The solar iron abundance: not the final word)

A particularly bad title

The paper studies whether the strong magnetism of „magnetic stars“ can be explained by the remnant of a field generated by a dynamo during an early phase of stellar evolution...

Axisymmetric α^2 -dynamamos in the Hayashi-phase

Received August 22, 1974

- jargon, incomprehensible to the non-expert
- irrelevant information („axisymmetric“, „ α^2 “)
- no indication of object, problem, result, ...

A particularly bad title

The paper studies whether the strong magnetism of „magnetic stars“ can be explained by the remnant of a field generated by a dynamo during an early phase of stellar evolution...

Axisymmetric α^2 -dynamamos in the Hayashi-phase

M. Schübler

Universitäts-Sternwarte Göttingen

Received August 22, 1974

- Magnetic stars: Origin of the field
- Where does the field of magnetic stars come from?
- An extinct dynamo as source of stellar magnetic fields?
- Early dynamo action explains magnetic stars

Authors & Affiliations

- Choosing the authors and their order can sometimes be a delicate matter.
 - Scientists do science because they enjoy it. However, they usually don't mind some recognition for their work, or their ideas → Co-authorship is a reward.
 - Authorship of good papers is crucial for a career in science
 - Deciding who should be a co-author, who should be in the acknowledgements & the order of authors. Different fields & groups have different traditions → talk to supervisor
 - **Never change author sequence on your own initiative only!**

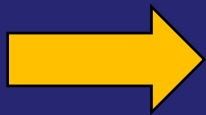
Authorship

- crucial: allocates credit for contributions, measures **achievement**
- results in **responsibility** for the complete content of the paper

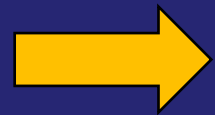
■ Who should be an author?

- intellectual contribution to the core of the paper
is both required and qualifies for authorship
- *„Each author must be able to take public responsibility for the contents of the paper, must be able to explain why and how the observations (the mathematical analysis, the simulation...) were made, and how the conclusions follow from the data (results).“*
[Style manual of the Council of Biology Editors, 1983. (...) by MS]
- other, more limited contributions in „Acknowledgements“
- „honorary authorship“ is **NOT** good scientific practice

- **Honorary authorship, why not?**
- reader can be misled about the quality/solidity of a paper having a non-contributing coauthor with a big reputation
 - first author's reputation increased at the expense of others who don't have big names on their list
 - honorary author receives undeserved credit („Matthew effect“)



Authorship requires a substantial scientific contribution



Research Note

**X-ray emission/absorption mechanisms of 4 NLSy-1-like AGN
and a radio quasar**

QSO 0117-2837, RX J0134.3-4258, NGC 4051, Mrk 1298, 4C +74.26

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„Meerschweinchen“ = Guinea pig !!

Better don't try hoaxes like that:
you will be made fun of
(such as it happens just now)

■ Order of authorship

- matters a lot („... et al."), but no unique practice
- often a progression with delivered effort or labor
- sequence should not hide a true „first author"
- alphabetic if contributions are equal, groups may permutate order in subsequent publications; info about individual contributions in footnotes
- the „Matthew effect": work becomes associated with the best-known author
- inform yourself, discuss authorship rules in your group!
- don't accept hierarchy, exertion of power... (easier said than done)

■ Responsibilities of authors

- review the manuscript, revised version etc.
- assure that proper procedures have been followed
- confirm that **proper** credit is given, relevant work is cited (includes also unpublished work, e.g. oral presentations, posters, or discussion remarks at meetings, which provided important input)

Affiliations

- **Affiliation:** Give the whole address when writing the affiliation of each author. For MPS authors:

Max-Planck-Institut für Sonnensystemforschung,
Max-Planck-Str. 2, 37191 Katlenburg-Lindau, Germany

- It is necessary to use **German original of our Institute's name on your papers**, to ensure that the institute is recognized in publication statistics (increasingly important for funding etc.)
- **E-mail address** could be useful (increasingly required by journals).
However: emails start to bounce some time after the author has left the institute...

Authors & Affiliations

- Write out first names or only use initials?
 - Check the guidelines of the journal
 - Full name is of advantage if
 - There is another scientist with your surname and first initial
 - You are a woman in a male-dominated field. Specially important if you are the only author, so that your work isn't cited as, "German idiosyncrasies have been charmingly discussed by M. Curie (2004). As he has shown...."
 - Your first name is particularly beautiful....
 - Make your name unique: J. Schmitt → J.H.M.M. Schmitt

Abstract (“the hook”)

- Golden rule for abstracts: make it short & concise
- ➔ Abstract should in general be less than 5% of the total length of the (journal) paper.
- Structure of abstracts: condensate of paper in one paragraph
 - 1-2 sentences on context & aims (WHY?)
 - short description of what has been done (HOW?)
 - main results & major consequences (WHAT?)
- Astronomy & Astrophysics favors “structured abstracts”:
Context – Aims – Methods – Results – Conclusions

Abstract

- SKS suggests using the active voice (first person)
- No figures, no tables, no footnotes
- Avoid references, abbreviations, equations and symbols. Make sentences short (always a good idea...)
- Write the abstract at the very end, once you are sure what the paper looks like and you have found the correct formulations for your main results

Abstract

- Exceptions to above guidelines:
 - Abstracts that will be published in abstract booklets (abstracts submitted to conferences). There it may be worthwhile to fill the space available.
 - Abstracts of review papers have a different structure. Reviews as a whole are structured differently than normal papers. However, if you are being invited to give reviews then you have probably published a number of papers already and do not need to listen to this talk (well...)

An example journal-paper abstract

Introduction Aim+Method Results Discussion

The extension of the sunspot number series backward in time is of considerable importance for dynamo theory. We have applied a physical model to records of the ^{10}Be concentration in polar ice to reconstruct sunspot number between the year 850 and the present. The reconstruction shows that the period of high solar activity during the last 60 years is unique throughout the past 1150 years. This nearly triples the interval of time for which such a statement could be made.

Another example...

Introduction Aim+Method Results Discussion

Summary. The evolution of axisymmetric magnetic fields during the Hayashi-phase is investigated on the basis of the α -effect dynamo mechanism. In particular, the influence of the transition from the fully convective to the fully radiative main sequence state (for A stars) is considered for rigid rotation. The fields are calculated by solving the induction equation as an initial value problem. The numerical results show that a dynamo-built magnetic field can “survive” the transition while conserving the main part of its total flux. The topology of the field can change significantly during the evolution.

For a certain phase of the transition to the main sequence there are oscillating fields, possibly giving an explanation for magnetic stars with long periods.

Key words: dynamo — α -effect — stellar evolution — magnetic stars

The Introduction

- In the introduction you describe the **background and context of your work**, i.e. what has been done before. This involves a short overview of the relevant literature. Keep the overview short: the introduction of a research article is not a review article. **But: Give adequate credit to the work of others!**
- Say why the present work needs to be done. Why it is important. If criticism of earlier work is necessary, try to be mild. You don't want others to be too harsh about your work either.

Introduction cont'd

- **Definitely needed:** Goals of your paper. If similar papers exist: what is new in the method or results.
- **Often done, but not necessary:** give structure of remaining paper in last paragraph of introduction.
- Many student authors find the Introduction the hardest section to write. They write it at the end, or even ask their supervisors to write it. Writing the Introduction is good practice. It forces you to learn what the importance of the work you have been doing is!
(Actually, you should be able to write the Introduction even before you start doing the science work...!)

Citations

- **Crucial way to give credit to the work of others.**
Citation counts are used to evaluate the impact of papers, often equated with scientific achievement.
- Never cite a paper without looking at it, just because other papers cite it. Avoid “wild citation” and too many unspecific citations (cite one or two reviews instead).
- Refer to someone by citing a specific and important paper, not to some arbitrarily chosen publication.
- Don't suppress citations just because they are from a competing group or you don't like the author(s).
- Don't cite papers that are irrelevant for your topic, just because the author is your friend, spouse, supervisor, or from your group.

Methods and Materials

- Describes the instruments and data used, as well as the analysis techniques. It may be called differently or can be broken into 2 or more sections.
- Examples of alternative titles:
 - **Computational technique**
(appropriate for a numerical paper)
 - **Instrument and measurements**
(e.g. if a new instrument is being described or used)
 - **Data and analysis technique**
(e.g. if the analysis technique is non-standard)
 - **Instrument and observations + Method of analysis**
(Section broken into 2 sections)

Methods and Materials

- Scientific results must be reproducible. Methods and Materials section is key to ensuring reproducibility of your results, since it describes what you have done, how you have done it and with which tools.
- The “when” can also be important: give the times & dates of your observations, specially when studying variable phenomena.
- This section is often studied carefully by the referee. It can decide whether he/she feels that the results can be trusted. If he/she feels that the technique is weak, the paper will be rejected.

Methods and Materials

- Find the balance between:
 - Describing everything important
 - Leaving out everything not needed.
- Rule of thumb:
 - New method, new instrument, new type of data
 - Describe in detail, since required for reproducibility.
 - Known method or instrument, previously described in other paper(s)
 - Often a reference and a short summary is sufficient.
- Do not repeat descriptions
- Often a figure can illustrate & clarify the method

Results

- The core of the paper, where the results obtained during the long labour of research are presented.
- Be concise. Pre-select the results (i.e. identify the important and new results) before writing about them in the Results section.

→ Keep in mind:

The fool collects facts, the wise man selects them

(John W. Powell)

(but don't be too wise: first collect the facts, then select them)

More Results

- Decide on what to put into the Results section and what to move to the Discussions section.
- General rule (but not a very hard and fast one)
 - In the results section you only describe the results, but do not interpret them very much.
 - In the discussion section provide the interpretation and the comparison with the literature, without repeating all the results.

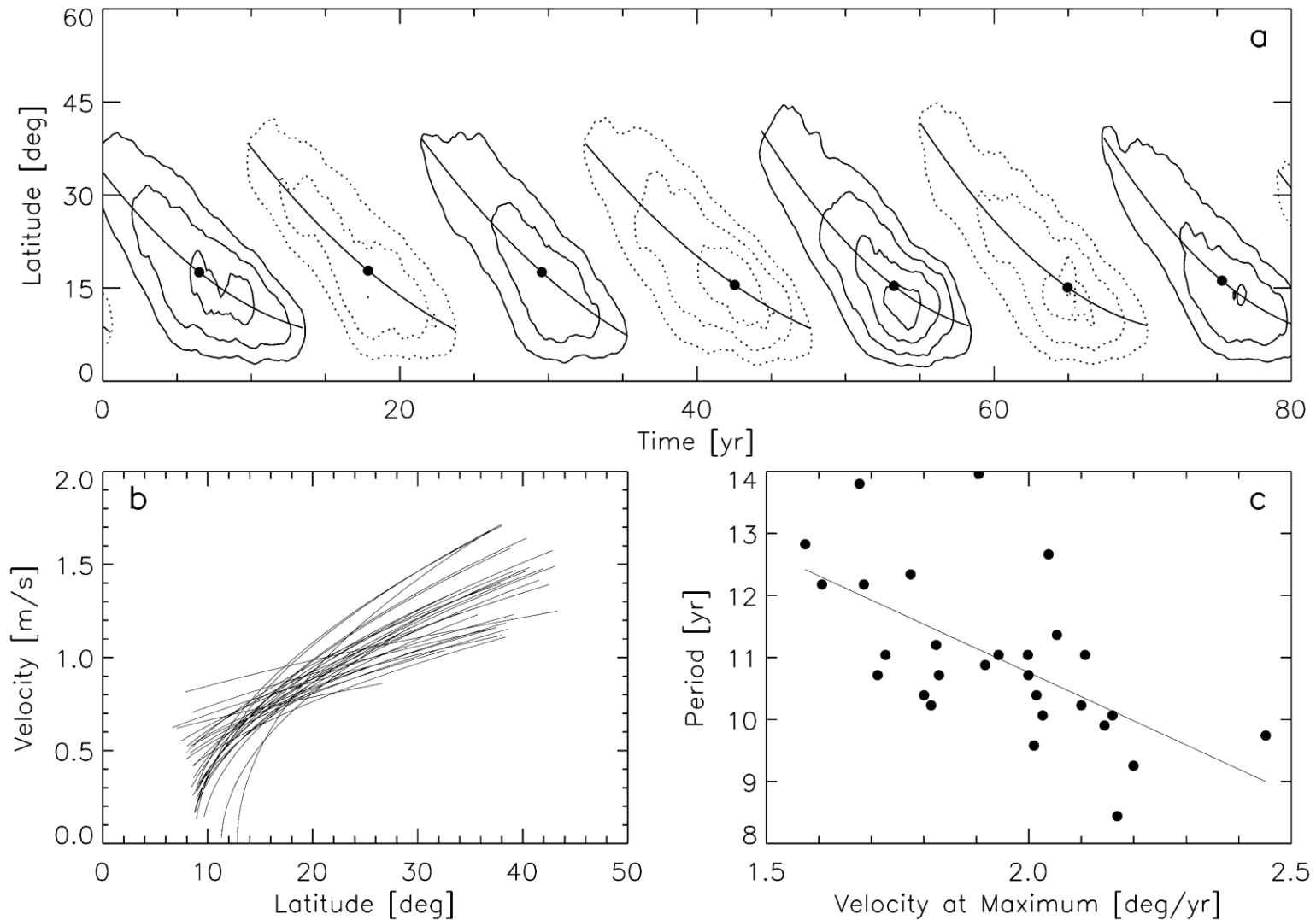
Results: Figures

- Use figures to show the main results if possible.
- Each figure must be referred to in the text.
- Each figure must have a caption.
 - Captions should be short, but self-explaining, since often figures are looked at before the text is read. I.e. if symbols or abbreviations are used, then they must have been defined in an earlier figure caption.
 - Captions should only clarify what is plotted and not try to interpret the figure. Interpret the figures in the main text.
- One way to structure this section is to write it around the figures. However, do not forget to make a logical order.

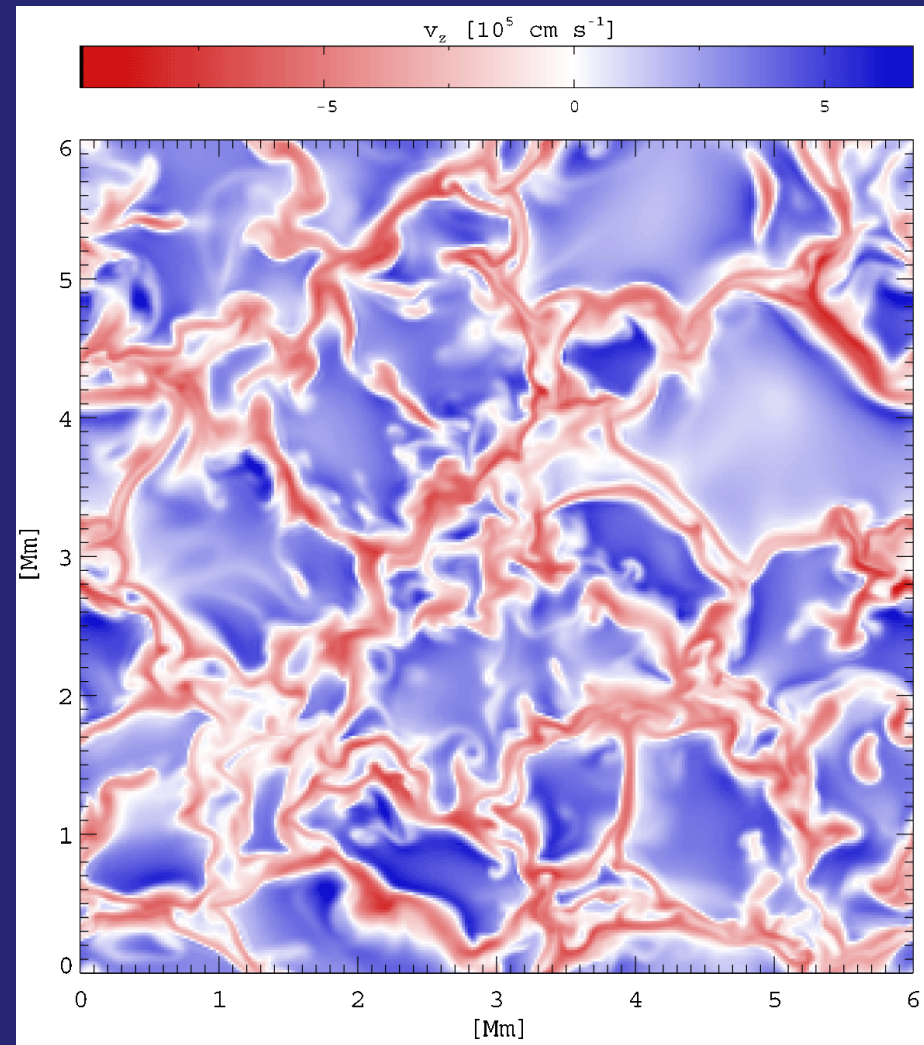
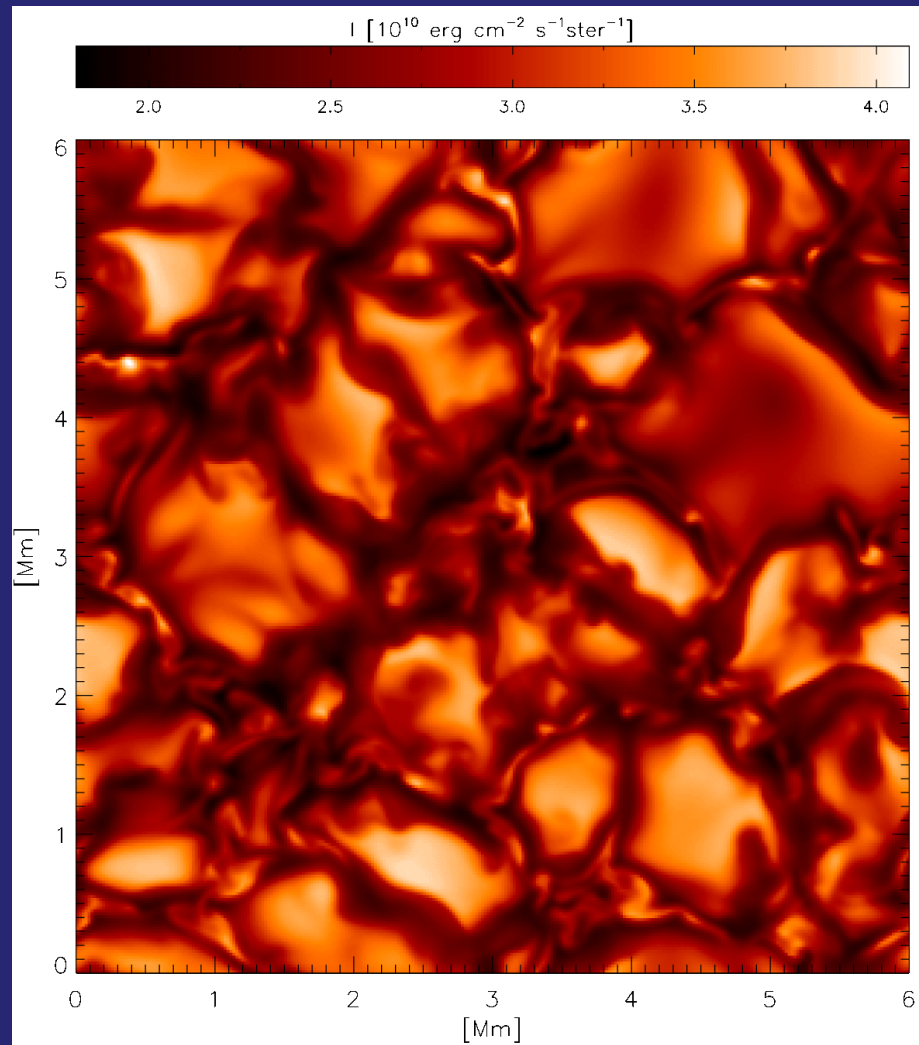
Types of Figures

- X-Y line graphs
 - If data points are linked by a line (shows dependence of one variable on another, with a particular order of the points)
- Scatter plots
 - Same as X-Y line graphs, but if the points are in no particular order
- Contour plots, surface plots, images
 - Different ways of representing 3-D data sets.
- Histograms, bar charts, pie charts
 - Representations of distributions, fractions & their evolution

Examples



Images



General Considerations

- Which results denote a figure or table?
- Order of figures and tables
- Grouping of figures and tables
- Eyecatchers
- Must be able to stand alone and be interpretable
- Final size

An Example

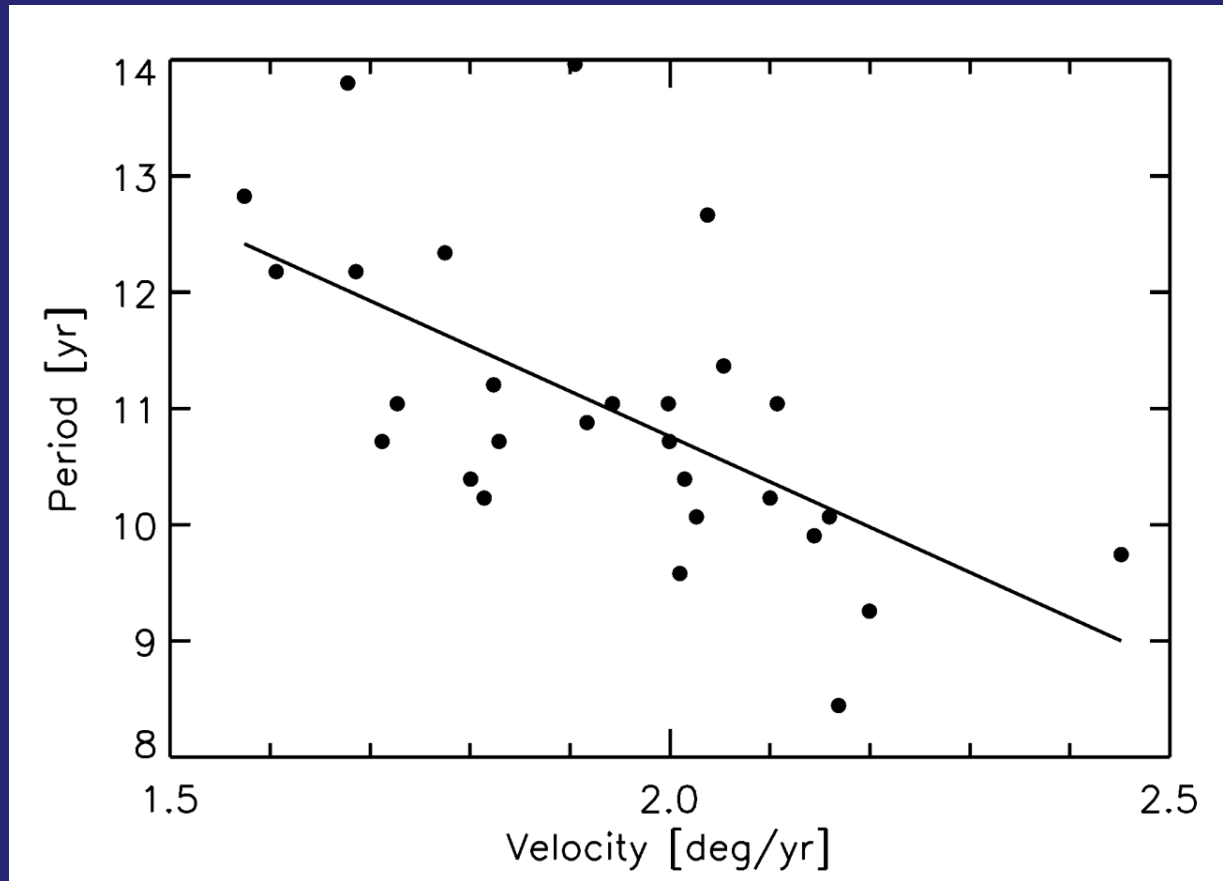


Figure 1. Solar cycle period vs. latitudinal drift velocity at cycle maximum, taken from an $\alpha\Omega$ -dynamo model. The dots represent the data of 28 simulated cycles and the line denotes a linear least-square fit.

Anatomy of a Figure

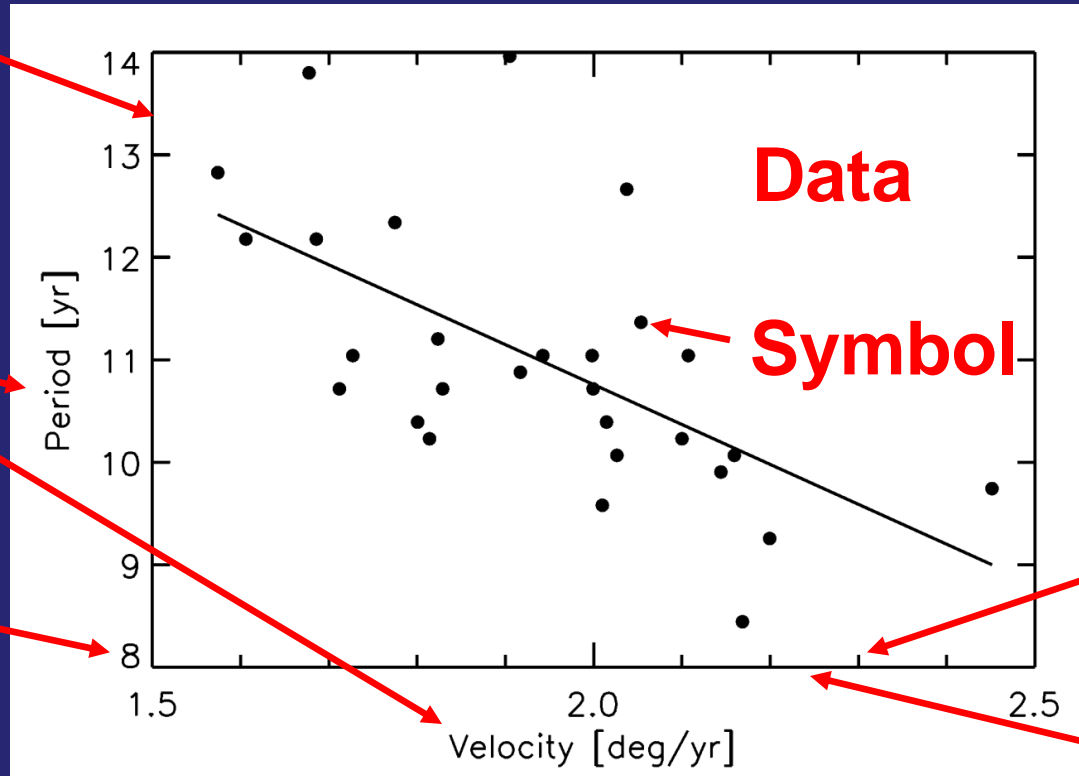
Title?

Y axis

Axis label

Major tick

Caption



Minor tick

X axis

Figure 1. Solar cycle period vs. latitudinal drift velocity at cycle maximum, taken from an $\alpha\Omega$ -dynamo model. The dots represent the data of 28 simulated cycles and the line denotes a linear least-square fit

What to observe when plotting figures

- Line thickness, image resolution
 - Labels, font type & size
 - Number and size of major and minor ticks
 - Axes range (round numbers, fill the frame!), linear/log scale
 - Line style, symbols (type & size), color (cost!)
 - Give a key to symbols (either in plot or in caption)
 - Don't overload figures (too many different quantities)
 - Caption: Should give all the information needed to understand the figure, but is not a discussion (exceptions are possible; e.g. main results).
- } Depend on final size of figure!

What About Colour?

- Colour is easily produced on the screen and colour printers are also common. However, publishing a paper with colour figures is still expensive
- Try to avoid publishing colour figures. Use different line styles (solid, dotted, dashed, etc.) instead of coloured lines, use B&W greyscales instead of colour tables unless the figure becomes incomprehensible.
- One possibility offered by some journals: No colour charges if the figures are in colour only in the electronic version, but B&W in the printed version.

What Not to do

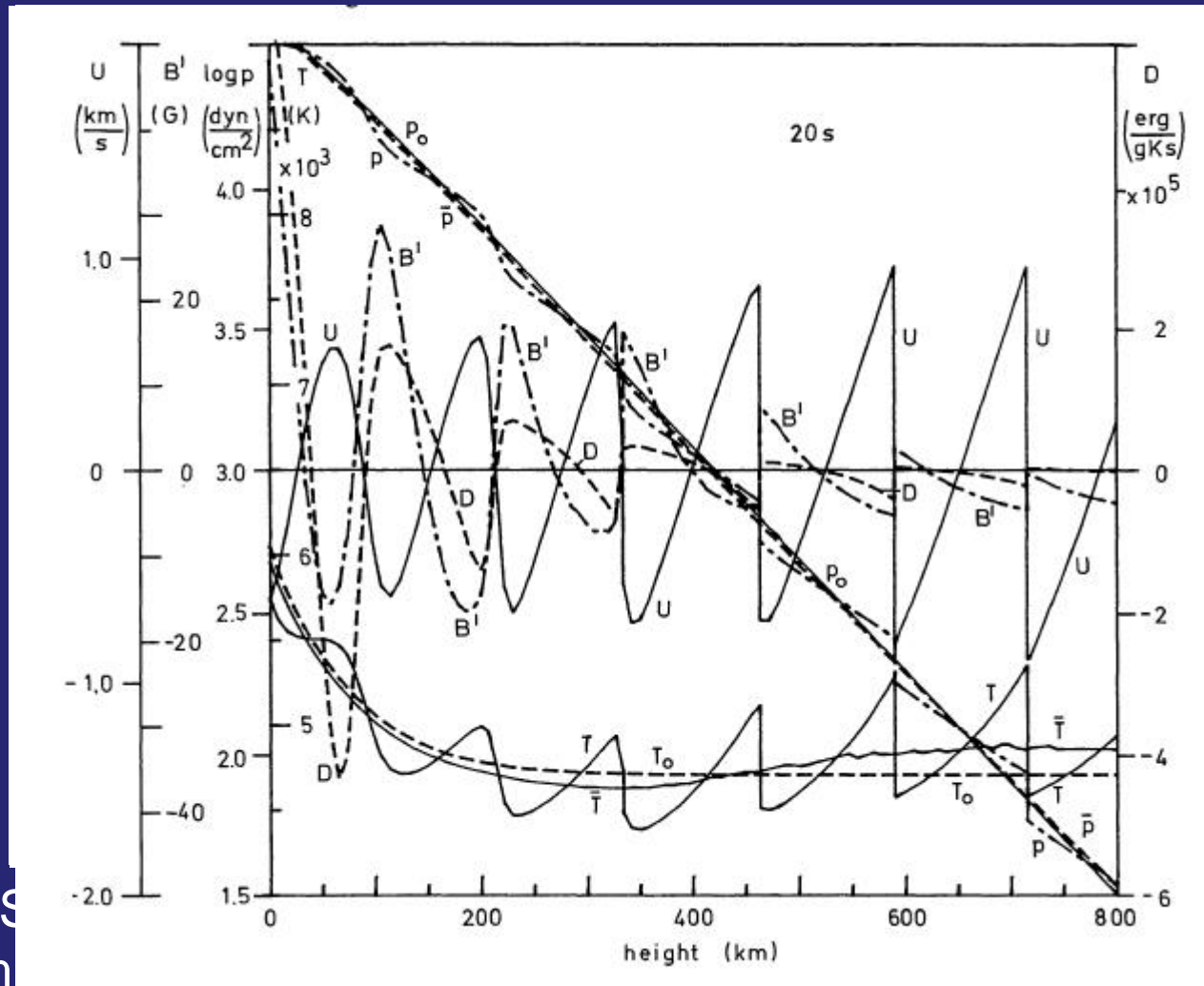
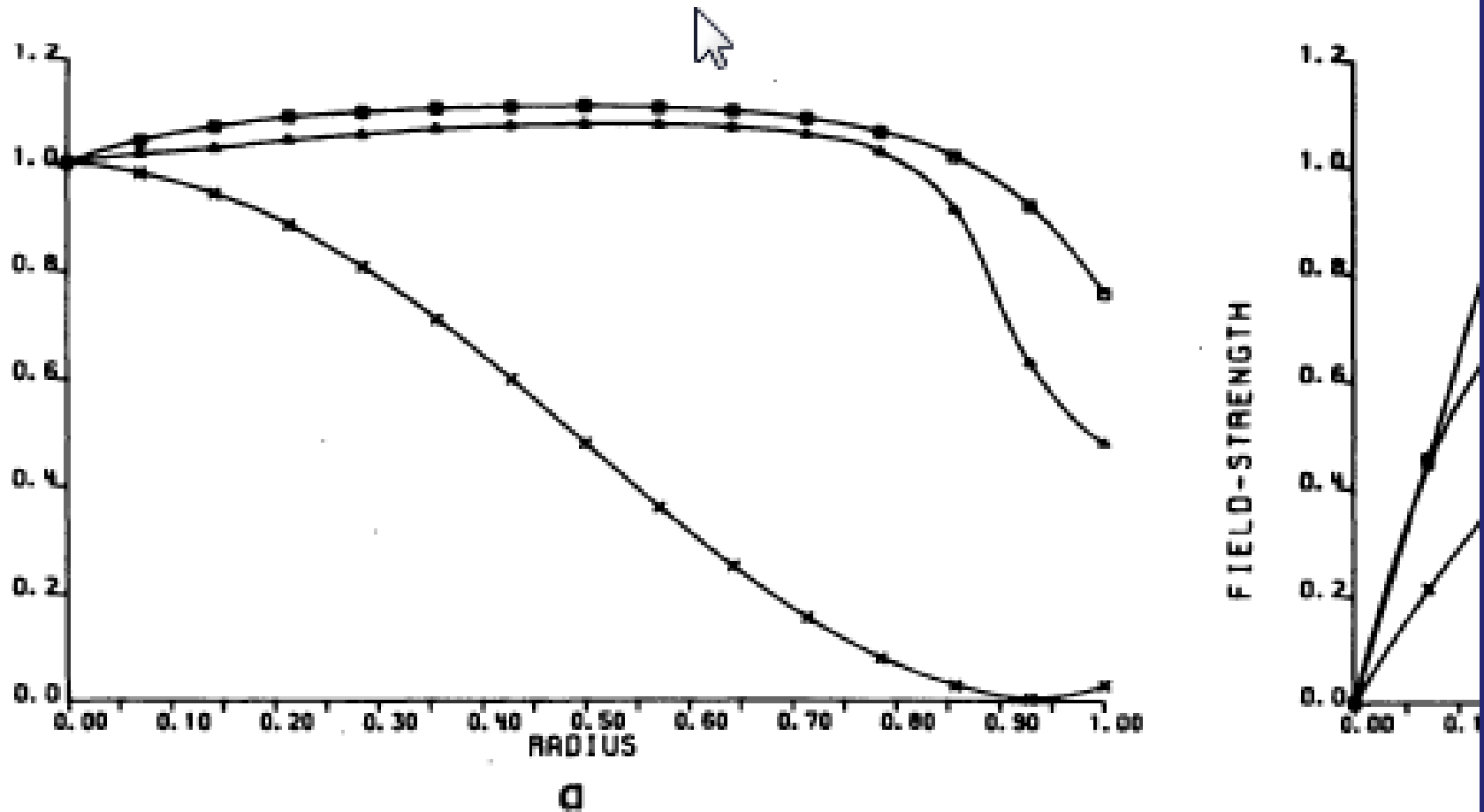


Figure 1. S taken from [reference] of 28 simulated cycles and the line denotes a linear least-square fit. Note the large scatter of the data points which contradicts earlier results by A. Zweinstein.

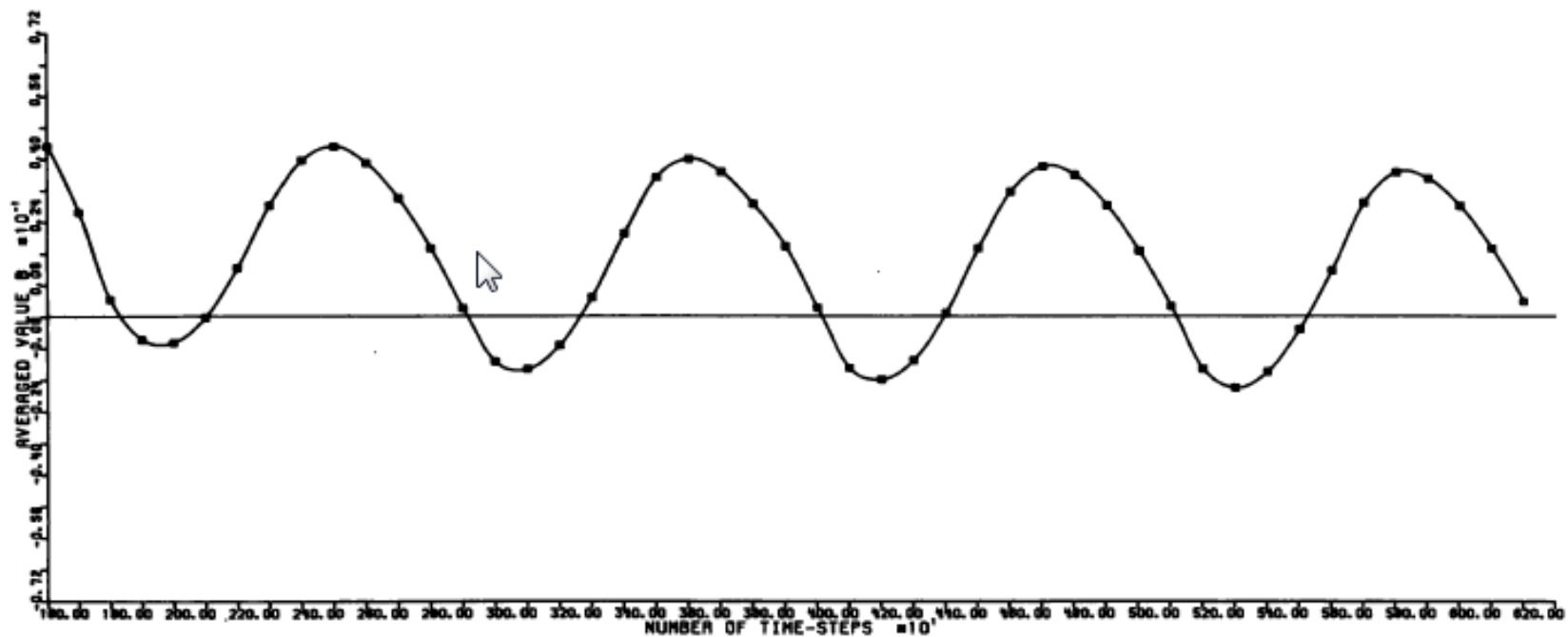
Another negative example...

M. Schübler



... and yet another one.

Axisymmetric α^2 -dynamo in the Hayashi-phase



Tables

- Make a table if you have multiple numbers to show
 - and you cannot put them into a figure,
 - or if the exact numbers are important
- Remember, figures are generally easier to read than tables.
- Tables may also be useful in the Methods section – e.g. a table of observations.
- Each table must have a title. Keep it short.
- Each table must be referred to in the text.

More Tables

- Describe the different columns of the table! E.g. as footnote to table or in main text (follow journal style).
- Some journals publish long tables electronically only. Possibly put them in appendix.
- Footnotes (e.g. sources of data are often given in the footnote of a table)

An example of a short Table

Table1. Descriptive caption above table.

Model	l [m]	v [m s ⁻¹]
A	1	10
B	3	-12
C*	5	15

*footnote

Discussion/Conclusions

- In this section the already presented results are discussed, compared with previous work, and put into perspective. Limitations, potential sources of error, and possible improvements are also discussed here. List your conclusions at the end: **stark conclusions must absolutely stand out!**
- Possible titles: Discussion, Discussion and Conclusions. Could also be broken up into two separate sections.
- It may be appropriate to repeat the MAIN result(s), but definitely not all of them.
- Often a difficult section to write. Drawing sound conclusions is not always straightforward. It requires some knowledge of the literature and experience in the topic of research.
However: If you don't know what to conclude from your results, you probably haven't quite understood what you are doing...

Acknowledgements

- The acknowledgements are placed between the end of the regular text and the references.
- **Always give credit** and acknowledge the help of others: supervisor (if not coauthor), colleagues, the referee,...
- Give credit to data sources (space projects, observatories), providers of equipment (e.g., external computer facilities), valuable services (such as ADS), and sources of financial support.
- People who have contributed to the paper, but not by a sufficient amount to be included in the author list, should be thanked in the acknowledgements.
- Discuss with your supervisor which people/services should be acknowledged.

Acknowledgements

- Acknowledgements & what they (should not) mean:
 - We thank A. Aabacher for helpful and clarifying discussions. → Sometimes means: the authors would have made total fools of themselves if A. Aabacher had not pointed out their error to them.
 - B. Bardot provided figures and input to the text, which is gratefully acknowledged. → B. Bardot wrote the paper.
 - C. Cardinale read through an earlier version of this manuscript → C. Cardinale found so many mistakes that the paper had to be basically rewritten.
 - We thank D. Duck for providing data and helping with their interpretation. → D. Duck actually did all the work
 - A poisoned acknowledgement:
We thank Prof. T.H.E. Boss for helpful discussions.
→ Boss did nothing, but successfully forced himself into co-authorship... (this actually happened in a Nature paper)

References

- Most important rule: **Check the style manual of the journal** to which the paper is to be submitted. Journals have widely different styles for references.
- Most used: Harvard system:
“(Name, Year)” in the text and references in alphabetical and chronological order, e.g.
 - Aabacher A., 1999, *J. Irreproducible Res.* 15, 16
 - Bardot B., 1988, *B&B* 1, 1111
 - Cardinale C., 1977, in *Old Movies*, ed. C. Chaplin, p. 777
 - Duck D., 1966, *The adventures of Daisy D.*, Disney Press
 - Duck D., and Mouse M., 1955, *Goofy’s Mag.* 13, 13
 - Duck D., McDuck S., and Mouse M., 1933a, *ApJ* 33, 333
 - Duck D., McDuck S., and Mouse M., 1933b, *ApJ* 44, 444

References

- Other journals: references are numbered in the order in which they are cited in text. Best use automated numbering scheme (provided by LaTeX)
- If you are using unpublished data or results of another researcher, then cite him/her in the text as, e.g., “M. Monroe (private communication)”. Ask before you cite!
- No private communications or unsubmitted papers into the reference list.
- Papers that have been submitted, but not yet accepted for publication are cited as “submitted”, those that have been accepted as “in press”.

References

- A lot of errors are propagated in the References
 - Make sure the references are correct! Check the paper directly, e.g. in a data base, such as ADS (Note: ADS references have errors and many BibTeX entries are incomplete. Send ADS an e-mail with any errors you find)
 - Are all papers cited in text also present in the references and vice versa
 - Check if dates, authors etc. agree between text & references; e.g. paper marked as “1995a” in both places
- BibTeX is a great help in this respect. Best combined with using the **natbib** package (`\citep{ref1}`, `\citet{ref2}`)
- ADS provides references in BibTeX format as well. Publishers have BibTeX style files for formatting references. However, ADS has many gaps in planetary science.

Appendices

- Material that may be of interest for a few readers, but not for most (e.g. lengthy tables, derivations of equations) can be put into an appendix or into multiple appendices.
- Most papers do not have an appendix.
- An appendix must be referred to in the main paper. E.g., “The derivation of Eq. (15) is given in Appendix B.”

Online material

- An increasing number of journals allow you to add online material, i.e. material that is published online, but not printed.
- Online material can include:
 - appendices
 - long tables
 - movies
- Since few people go to the library anymore to get a publication, this is often a good way of extending the presentation of your results.

After finishing to write

- Revise
- Important: be consistent. Make sure that you say the same thing everywhere in the paper.
- Show the paper to your supervisor!!!

Style

- Scientific publications have their own style, different from the spoken work, different from the style of newspapers, or most literature.
- The aim of a scientific paper is to transmit what you have done and the results you have found. Remove everything not needed for this.
- The style should be clear, simple and concise.
- Golden rule No. 1 of paper writing style: **KISS**
Keep It Short & Simple
- Golden rule No. 2 of paper writing style: **KISS**
(for those not paying attention to Golden Rule No 1)
Keep It Simple, Stupid!
MS's rule: clarity first, then KISS

Clarity is crucial

You can't properly explain things to your readers unless you have properly understood them yourself.

Don't try to escape by using vague wording.

An additional hour spent with improving and clarifying your explanations & arguments may well save you many hours revising your paper after a negative referee report.

Style: jargon

- Avoid jargon! I.e. do not use unnecessarily many, long and abstruse words to hide your meaning. Do you recognize the well-known adages (the sayings) in these examples of “Jargonese”?
- A sedimentary conglomerate in motion down a declivity gains no addition of mossy material
→ A rolling stone gathers no moss (J-factor of 3)
- There is a large body of experimental evidence which clearly indicates that members of the genus *Mus* tend to engage in recreational activity while the feline is remote from the locale.
→ When the cat is away, the mice will play (factor >4)

Style: Jargonese the 2nd

- As a case in point, it has been proposed by numerous authorities that slumbering canines are best left in a recumbent position.

→ Let sleeping dogs lie. (J-factor of 6)

- From time immemorial, it has been known that the ingestion of an “apple” (i.e. the pomme fruit of any tree of the genus *Malus*, said fruit being usually round in shape and red, yellow, or greenish in colour) on a diurnal basis will with absolute certainty keep a primary member of the health care establishment absent from one’s immediate environment.

→ An apple a day keeps the doctor away. (factor >10)

Style

- Many publications are often written in an impersonal style (probably to make them appear more objective). Often the passive voice is employed. Also, in many papers written in the active voice, “we” is used, even if only a single author is present.
- My suggestion:
 - Use the first person. Use “I” if you are the only author.
 - Sentences that become too long are hard to understand. However, if all sentences are very short, the text appears to be disconnected.
 - Reading papers written by leading scientists who are native english speakers can help, but be careful, some of them also use jargonese....

Don't forget the reader

- Write at a level for PhD students working in the same general field. E.g., a planetary atmospheres paper should be aimed at atmospheric planetary scientist, but not specializing in the same planet.
- The 4 principles of writing for the reader:
 - The clarity principle: Make things clear to the reader, but do not give more information than is necessary.
 - The reality principle: Assume that readers know how the world works (no need to tell them all again), but tell them anything you believe they may not know & need to know.
 - The relevance principle: Stick to your topic and don't lose the aim of your paper from sight.
 - The honesty principle: State only what you can provide evidence for.

Style, in short:

- write clearly,
- write accurately,
- be brief (avoid verbose and pompous styles),
- build a logical structure: the train of thought should be logical, avoiding a winding and repetitive course in the suite of ideas.

Style: The Dos

- Spell out your assumptions (Intro. or Methods Sect.)
- Be as precise as possible. Provide numbers!
- Avoid using too many abbreviations. Define the abbreviations the first time they are used.
E.g.: “Another name for Father Christmas (FC) is Santa Clause (SC). FC does most of his work in the run up to Christmas and so does SC, of course.”
- Define all symbols the first time you use them
- Give the units!! SI units are now generally used.
- Use *italics* sparingly, avoid **bold face** etc.

Style: The Don'ts

- Writing things that you do not understand (e.g., e.g., i.e.)
- Drowning in acronyms
- Mixing American and British styles (e.g., ...ise ↔ ...ize)
- Inconsistent capitalization (e.g., Moon ↔ moon)
- Footnotes (interrupt the reading process)
- Unnecessary emphasis (e.g., “existing calibrations”)
- False friends (eventually ↔ eventuell ↔ eventuellement)
- Sexism (his/her)
- Non-standard nomenclature

Style: The Don'ts

- Avoid everything listed in the viewgraphs on how **NOT** to write a scientific paper.
- Don't copy sections or paragraphs from other papers, including your own, even if this seems inviting since they are already well formulated. You may end up with a paper that is both “good and original”, but “the parts that are good are not original and the parts that are original are not good” (Samuel Johnson).
- Copying is ethically wrong, specially from other authors' papers. Students caught plagiarising can get thrown out of their PhD programs. Plagiarism is likely to end your scientific career, or even your career outside science!

Don't even think of „borrowing“ somewhere else...

Nature **444**, 524 (Nov. 2006)

Automatic analysis of 280,000 entries in the arXiv preprint server for duplication and plagiarism (D. Sorokina, Cornell)

0.2 % Blatant plagiarism

11 % Duplicate publication
(without proper reference)

Many cases of students copying verbatim from other sources

„Clever plagiarism“ not as easily found by simple text comparison

Logical sequences and connectors

- **Typical problem with papers written by beginners.** Thoughts are put to paper, but without making sure that each sentence follows logically from the previous one.
- **Important:** The sentences within a paragraph should follow a logical sequence (i.e. it should be possible to rearrange the sentences and someone else would still be able to put them back into the correct order again). Examples are given in following slides; as an exercise)
- ➔ Importance of connectors

Style & language

- Scientific english would be a whole lecture course in itself.
- Here I consider only 2-3 aspects.
- For example, it is important to have a handy list of verbs to use. E.g. for Figs. avoid using “shows” 20 times over (typical for beginners). Alternatives:
 - displays, exhibits, illustrates, highlights, reveals, uncovers, ... can be seen from Fig. ... , ... can be deduced from Fig. ..., in Fig. ... we plot, sketch, draw, Fig. ... is a plot of, is a sketch of

Style & language

- Placing of words and commas in sentences can make a BIG difference.
 - Put “only” at different places in the sentence:
I hit him in the eye yesterday.
 - **Only** I hit him in the eye yesterday.
 - I **only** hit him in the eye yesterday.
 - I hit **only** him in the eye yesterday.
 - I hit him **only** in the eye yesterday.
 - I hit him in the **only** eye yesterday.
 - I hit him in the eye **only** yesterday.
 - I hit him in the eye yesterday **only**.

Style & language

- Comma or no comma? What is the difference in meaning between the following phrases?
 - No price is too high!
 - No, price is too high!
- Where to put punctuation in following sentence?

Woman without her man is an animal.

Woman, without her man, is an animal.

Woman — without her, man is an animal.

Submitting papers to journals

- Scientific contributions by all authors, no contributors left out
- Consent of all coauthors to submit the paper
- Some journals demand statement of „author contributions”
- Obtain permission to use copyrighted material (figures...)
- No parallel submission to other journals
- Declaration if manuscript has been previously submitted to another journal (and was retracted/rejected).

Upon request, provide the editorial correspondence, including referee report(s).

Which journal?

- Criteria for choice of journal:
 - The journal should cover your field and should be read by colleagues
 - The journal should have a good reputation.
 - Monetary considerations:
page charges (if any), cost of printing in colour?
- Examples of appropriate journals:
 - General: Nature & Science
 - Physics: Phys. Rev. Lett., Phys. Rev. A-E
 - Astronomy (including solar system studies): Astronomy & Astrophys., *Astrophys. J.*, Monthly Not. Royal Astron. Soc., *Astron. J.*, *Publ. Astron. Soc. Japan (or Pacific)*

Which journal?

- Examples of appropriate journals (contd.)
 - Specializing in solar phys.: Solar Physics; JGR A, GRL
 - Specializing planetary science & geophysics: JGR, GRL, Annales Geophysicae, Icarus, Earth Moon & Planets
- What determines the reputation of a journal?
 - Impact factors: How often articles in the journal are cited on average in the first 2 years after publication.
 - Nature \approx Science $>$ PNAS \approx Phys. Rev. Lett.: highest impact factors.
 - **Important**: Citation rates are very much field dependent
 - **Important**: Better a high impact paper in a low impact journal than vice versa!
 - What scientists think of a journal \rightarrow talk to your supervisor and other experienced scientists in your field.

Open access?

- All things being equal, I would tend towards open access journals.
- What are open access journals? These are journals that do not demand readers to pay. They provide free access to scientific results, as it ideally should be. But the cost of publication needs to be covered: usually by page charges.
- Open access journals without page charges are still relatively rare, since some independent body must pay for them (e.g. the MPG and MPS for Living Reviews in Solar Physics: <http://solarphysics.livingreviews.org>)
- Commercial publishers adapt: they allow authors to make their papers accessible on public repositories (such as arXiv or the Max Planck Digital Library)

The refereeing process

- Every suitable paper submitted to a respectable journal is sent to a referee (in some cases two) to judge its merit and to advise the editor to accept or reject the paper. The editor decides!
- The referee will generally advise to either
 - publish without changes (rare)
 - publish with minor changes (the referee does not generally see the modified version again before printing)
 - publish with major changes (the referee is sent the revised version to comment on)
 - not publish in its present form, but resubmit after major modifications (to then be treated like a new submission)
 - not publish at all.

Contributors' most common mistakes

- **Organization and Presentation (50):**
Rambling – do not show problem or significance of results; no summary; failure to make a case; failure to cite previous work; too long – overly detailed information; poor graphics; no mention of uncertainties.
- **Manuscript (21):**
Failure to follow instructions for authors.
- **General (15):**
Unaware of the scope of the journal – look at a few issues and see what we publish; too PR oriented – tooting their own horns; insignificant papers – not up to professional standards.
- **Expression (8):**
Lack of clarity, conciseness (try to write clearly, not profoundly); failure to write for the audience

Dealing with referees' reports

- At first sight referees' reports often look more negative than they really are.
- ➔ Read the report, show it to your supervisor. If rather negative then put it away for a few days (to calm down). Only then read it again & make the requested changes to the paper.
- When sending back the revised paper, also send back a reply to the referee, pointing out how you have taken his/her comments into account in the revised manuscript. If you disagree with the referee and haven't taken a suggestion into account, politely explain why not.
- Referees are not always stupid. If the referee does not understand something, then maybe the paper is not clear. Make it clearer.

Dealing with referees' reports

- Remain polite. Usually the referee is trying to help. It is better that the referee catches any errors before the paper is published. Even if the referee is nasty, usually little is gained by showing your anger.
- If you feel that you are being unfairly treated by the referee you can ask for a second opinion. Only worth doing if your paper gets rejected and you have good scientific arguments why the referee's criticisms are unfounded. Editors generally send the paper **and** the report of 1st referee to 2nd referee. If this referee also rejects the paper, then that is it.
- Example of an exception: Parker's solar wind paper

Crimes of Referees

- Sometimes referees really are unfair. Examples of referee's misdemeanors (luckily very rare!):
 - Stealing an idea from a submitted paper written by a novice (happened to Jack Harvey).
 - Instead of pointing out an error in the report, accepting the paper and writing a paper attacking that error (happened of Eugene Parker)
 - Stating that the paper needs to contain more material (a difficult one for editors to catch)
 - Making general statements about the quality of the paper without pointing out what is wrong specifically (e.g. "results are obviously wrong")

Being a responsible referee...

*E.N. Parker, „The martial art of scientific publishing“
EOS 78, 437 (1997)*

The all too clever referee... (1959)

- Parker submits a paper to a „well-known journal“
- inquiring the editorial office after two months, the answer is that the referee („an important and busy man“) would answer soon
- same brush-off on further occasions
- Parker realizes that his paper contains a serious error and drops it
- After 8 months, the referee report arrives saying that the paper could be published in a „suitably brief form“. Parker declines.
- 2 months later, a paper by a well-known plasma physicist appears in the same journal with the sole purpose of pointing out the error in Parker´s unpublished paper (cited as an in-house report).
- Parker: „I was flattered that even my unpublished work merited attention in a national journal“ ;-)

Making your paper available to the community

- Publication takes 4-10 months from submission
- Scientists therefore often used to send (printed) “pre-prints” to each other
- Now electronic preprint servers do the job:
 - I suggest you put your paper on the arXiv/astro-ph server (certainly solar papers): <http://arxiv.org>
 - Solar papers put on this preprint server are cited twice as often as papers not on the server (open access!!)
 - Careful: wait until your paper is accepted for publication before you put it there! Otherwise you might have a paper in public that bears little resemblance with the published one..
 - Citing accepted papers on astro-ph: cite them as “in press astro-ph/.....” (number assigned by data base to your article)

Ph.D. Theses

- Basic structure of a Ph.D. thesis can follow two paths (some universities leave you no choice):
 - Path 1: Like a long research paper: IMRaD (or similar)
 - Path 2: A succession of almost independent research papers bounded by an introduction and final conclusions.
- In both cases the following parts are necessary:
 - **Summary** [language(s), form & length often prescribed by the university]
 - **Introductory chapter**: Review of the field, to show that the student has mastered the literature and background.
 - **Conclusions chapter**, including an outlook for future work. To show that the student has got his/her own ideas for future work & is ready for independent scientific work.

Ph.D. Theses

- Both IMPRS partner Universities allow paths 1 or 2. No need to rewrite the text of the papers.
- A Ph.D. thesis is longer than a typical research paper, i.e. there is more space for writing about details, specially about the methods.
- Chapter(s) on methods and materials are obligatory only if Path 1 is followed, but are often also introduced for Path 2, since more space is available (see point above).
- For path 1 the references are best listed at the end of the thesis, for path 2 after each chapter.

Ph.D. Theses

- Questions can arise if there are multiple authors of a given paper forming a chapter of a thesis and in particular if the student is not the first author. Often a written statement from the student is required by the university pointing out his/her exact contribution.
- I tend to allow my students more freedom with individual style in the thesis than in papers. However, supervisors differ in this respect.

Ph.D. Theses

- In the IMPRS we expect each Ph.D. thesis to contain the material of multiple research papers.
- Remember that your thesis will be carefully read by multiple people and you will be questioned about it.
 - ➔ Don't take writing your thesis too lightly.
- However, very few theses are read as often as research papers once the student has got his/her doctorate (although they are often given to new students starting on a subject as an introduction)
 - ➔ Avoid unnecessary perfectionism.

Posters

- A poster must be attractive and should bring its main message across in 5 minutes (divide the number of posters at a meeting by the lengths of the poster breaks...)
- Basically a poster is an extended abstract with pictures and captions
 - Rules Nos. 1+2+3: **Less text!**
 - Rule No. 4: Show only the absolutely main result(s)
 - Rule No. 5: Use **big** fonts, to be readable from 2m away!
 - Rule No. 6: A picture tells more than a 1000 words
 - Rule No. 7: Do not clutter. Space looks attractive.
 - Rule No. 8: **Use colour!**
 - Rule No. 9: Avoid tables. If at all, only very short tables.

Posters

- Possible structure of a poster:
 - Title (**BIG**) + authors + affiliations
 - Abstract
 - A very short Methods and Materials section (can in some cases even be left out)
 - Main Result, or Results (the bulk of the poster)
 - Conclusions (short)
 - Few references (even no references is o.k.)
- In contrast to a paper in a refereed journal, the results presented in a poster and published in proceedings can be preliminary.

MS's main message...

- Publications are what people eventually see as the result of your scientific work (talks are „teasers“).
- The quality of your work is judged by the quality of your papers.
- Therefore, it is crucial to put every effort into writing good papers: **clarity**, style & form, attractiveness, ...
- Don't submit a half-baked manuscript: the referee is your most important reader & potential multiplier.
- Anything sloppy in your papers fires back upon the conscious or subconscious perception of your work:
sloppy paper → sloppy science

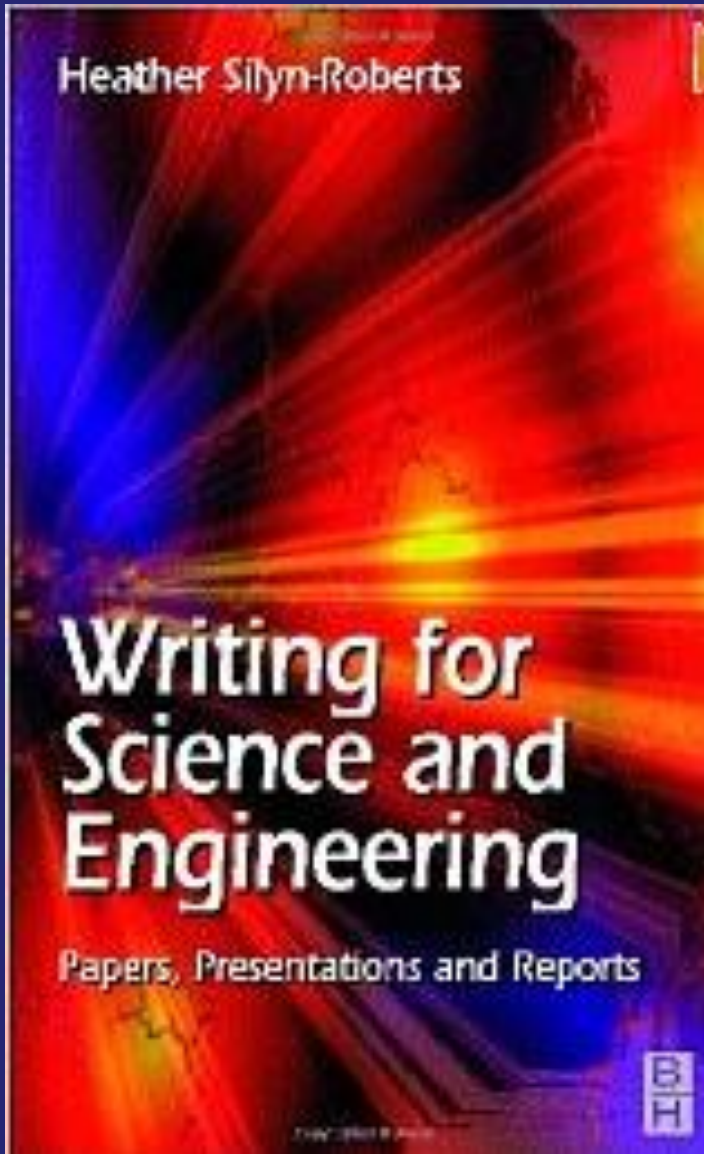
„Clear communication, which is the prime objective of scientific reporting, may be achieved by presenting ideas in an orderly manner and expressing oneself smoothly and precisely. By developing ideas clearly and logically, you invite readers to read, encourage them to continue, and make their task agreeable by leading them smoothly from thought to thought.“

Publication Manual of the American Psychological Association

Acknowledgements

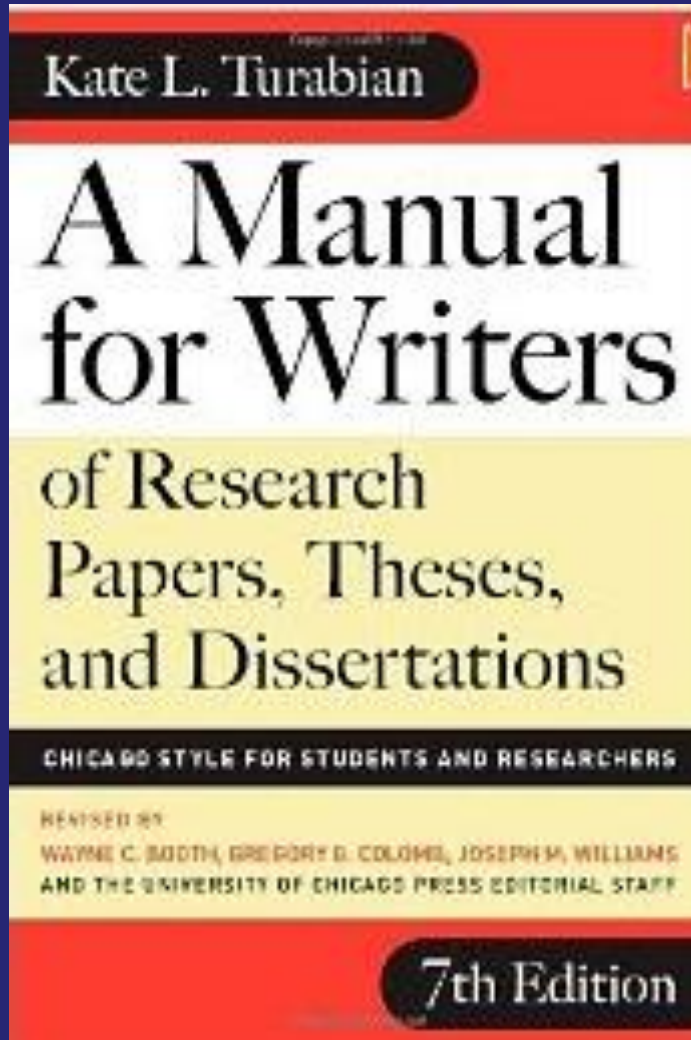
- Dieter Schmitt provide crucial help with sources and with the slides describing figures and tables.
- Robert Day's book on "How to write and publish a scientific paper" is a rich source of material, both serious and not so serious. Many of the examples and cartoons are borrowed from there.
- Daniel Stotz, whose lecture notes on "Writing English for Science" was another great source of inspiration and material.

Relevant books in the MPS library



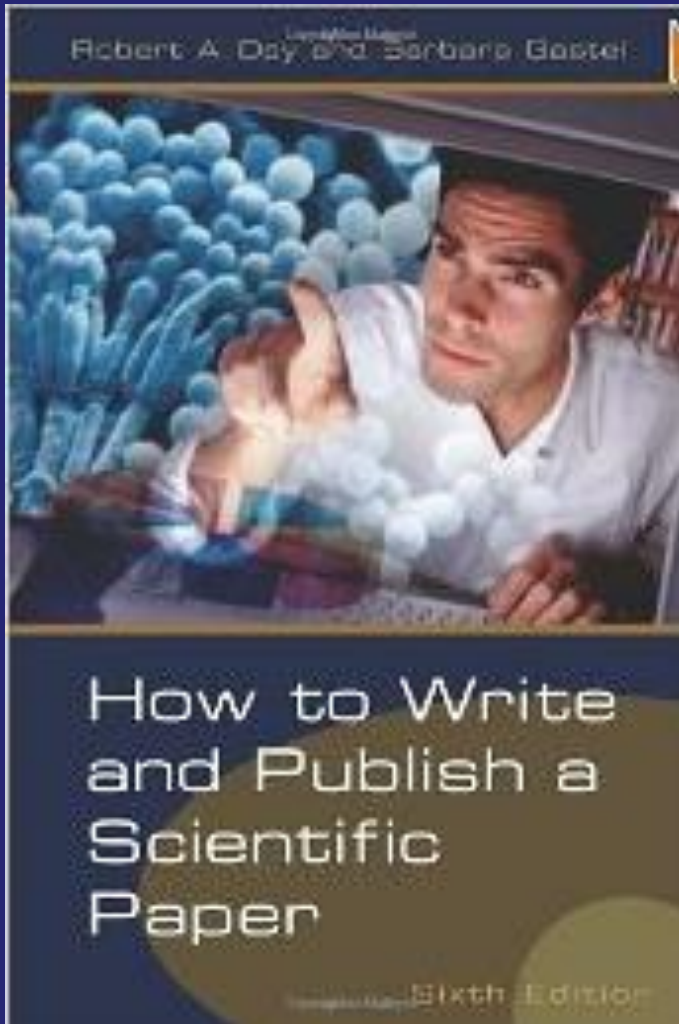
Heather Silyn-Roberts:
Writing for Science and Engineering
Butterworth-Heinemann, Oxford

Relevant books in the MPS library



Kate L. Turabian:
A Manual for Writers of Research
Papers, Theses, and Dissertations
University of Chicago Press

Relevant books in the MPS library



Robert A. Day & Barbara Gastel:
How to Write and Publish
a Scientific Paper
Cambridge University Press

Relevant books in the MPS library

Tim Skern
Writing
Scientific English
A Workbook

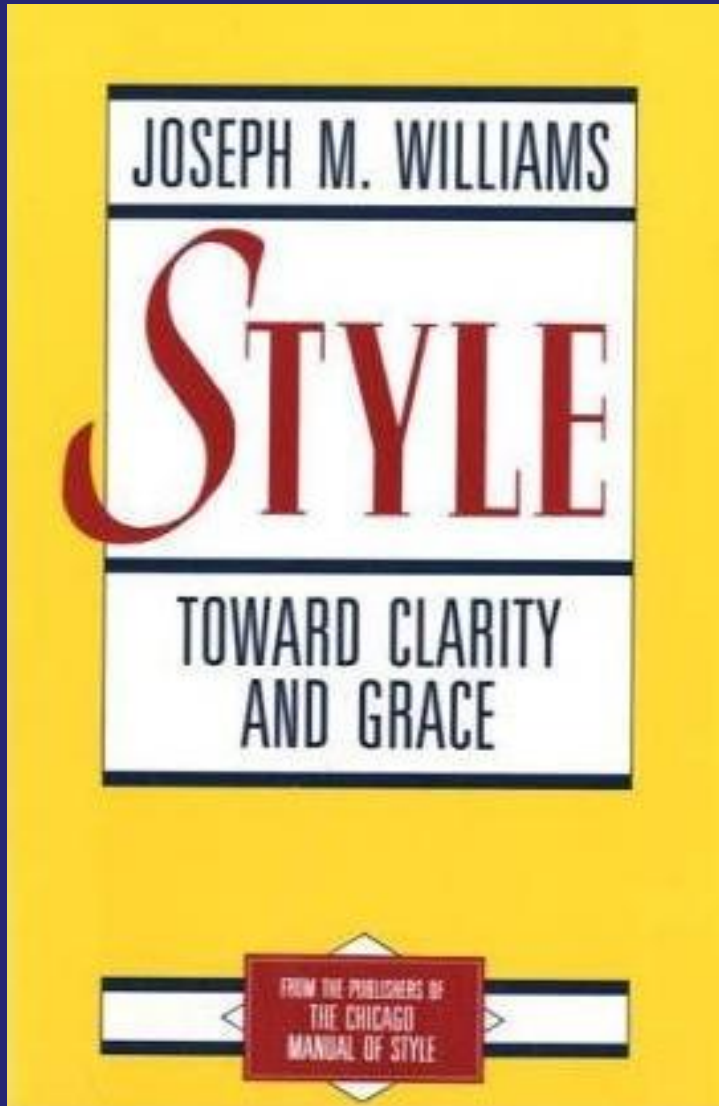
haben, erfolgreich
sich / (person) Er
successful [sək'sesfəl] Et
be - erfolgreich sein
mit, bei), to be entirely
sein; I was - in doing it
zu tun.
successfully [sək'sesfəli] a
mit Erfolg.
succession [sək'seʃən] n f.
(with no intervening period)
der/folgt, Kette f. • at the
Kette or Serie von Besuchen
of jobs and surveys
Wörterb.

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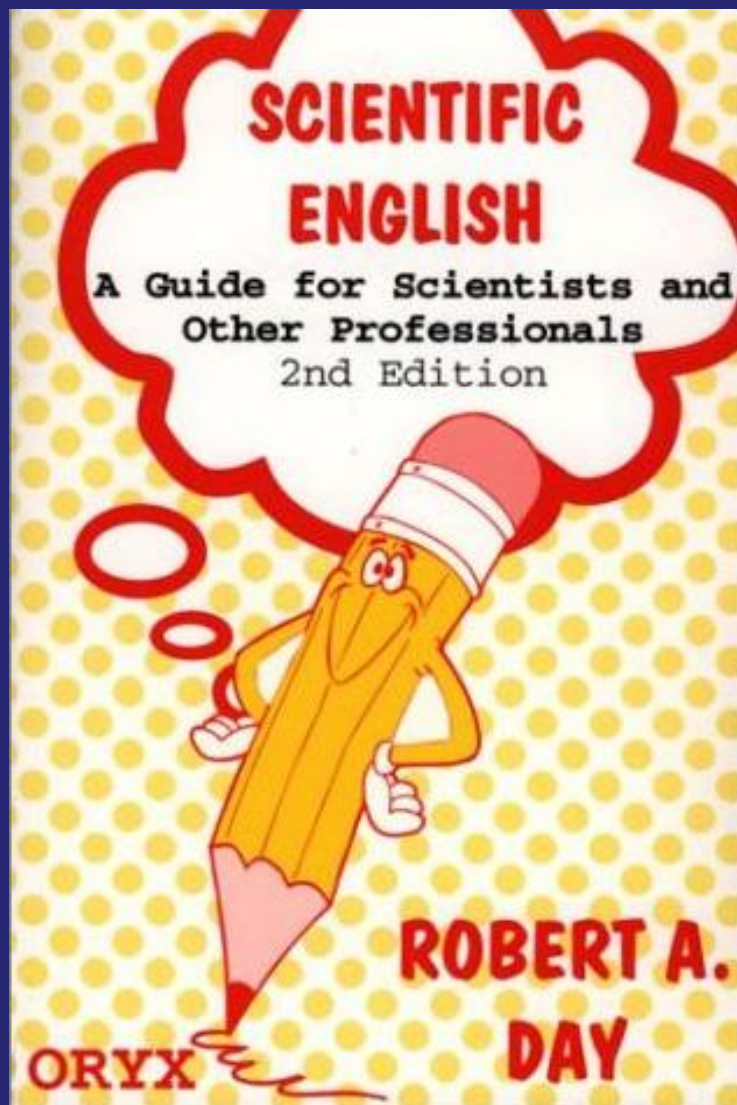
Tim Skern:
Writing Scientific English
Facultas.wuv, Vienna

Relevant books in the MPS library



Joseph M. Williams:
Style: Toward Clarity and Grace
University of Chicago Press

Relevant books in the MPS library



Robert A. Day:
Scientific English - A Guide for
Scientists and Other Professionals
Oryx Press, Westport, USA

Also of interest...

Chris Sterken: Advice on Writing a Scientific paper,
in „Astrophysics of Variable Stars“,
eds. C. Sterken & C. Aerts,
ASP Conf. Series Vol. 349, p. 445 (2006)