Writing a First Scientific Paper

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1. Introduction

These notes are intended as a guide for research students preparing their first paper for publication in an international science journal. Writing is a highly personal activity and each of us tends to develop our own style and as such these notes should be regarded as providing hints to assist the student but it is not my intention, or desire, that they should be followed slavishly. While these notes undoubtedly reflects the author's background as a physicist most are probably relevant to almost any scientific endeavour.

2. Types of Journals and Articles

2a. Review Journals

Some journals are devoted solely to the publication of reviews of developments in a particular area of a science (e.g. *Reviews of Modern Physics, Reports Progress of Physics, Physics Reports*) and are normally written by persons already established in a particular field and as such fall outside of the province of these notes. Some journals carry reviews as well as original papers (e.g. *Nature, Science*).

2b. Rapid Communications

Several journals exist solely for the rapid publication of original work of special significance (e.g. *Physical Review Letters, Physics Letters, Chemical Physics Letters etc*). Other journals carry a special letters section for a similar purpose (e.g. All the journals of the UK Institute of Physics such as *J. Phys. A,B,C,D,E,F,G series* , *Nature, Science*). These are usually quite short papers often of just one or two pages. While publication is usually rapid there is often a high rejection rate. Papers that do not represent a significant, possibly outstanding, development are likely to be rejected as more suitable for conventional publication as an article in a standard scientific journal.

2c. Normal Scientific Papers

The bulk of scientific papers appear in standard journals and may consist of a few pages or many pages (~ 30) and involve the reporting of *original* scientific work. They may be presenting the results of new experiments carried out by the authors, a theoretical analysis of experimental results, a new theoretical development of some aspect of a science etc. Typical journals would include *Phys. Rev., J.Math.Phys., J. Chem. Phys., Int. J. Quantum Chem., J. Phys. A...G, Nucl. Phys.* etc.

3. Is it Original?

A prime criterion for publication in a scientific journal is that the work be original. This usually means that your contribution is significantly different from any previously published work on the subject. In experimental work your contribution might involve a new technique, an improvement in the precision of a measurement, in rather rare cases confirmation of an existing experimental result, new experimentally obtained information about some system. In theoretical work your contribution might involve a new interpretation of experimental data, a new method of solving a theoretical problem or in some cases the recognition that a theoretical method developed in a particular field is relevant to the solution of problems in a different field.

The onus is on you to initially determine whether your contribution is original. This usually involves a search of the relevant literature to see what is already known. This might involve searching abstracting journals (e.g. *Physics Abstracts, Chemical Abstracts, Mathematical Reviews*), exploring various databases (e.g. *Silver Platter* (*Mathematical Reviews* on searchable CDROM), *Science Citation Index* (also on CDROM), *Current Contents* (also on CDROM), the various Los Alamos searchable data bases [Polish users should try the mirror sites http://babbage.sissa.it/ or http://xxx.uni−augsburg.de/] available to Netscape users). Be particularly careful to check *both* Eastern and Western literature. Ideally you should have made such an investigation at the beginning of your researches and indeed also during your researches.

4. Is it Patentable?

It is as well to remember that if your discovery is patentable you may lose your patent rights if you publish prior to filing a patent. If your discovery is patentable you will probably want to search one of the commercial patent data bases. If your search result is negative then you are making progress!

5. Who are the Authors?

Before going to print ask yourself "to whom does this publication belong?" Is it solely my work or is it the work of several people who themselves should be among the authors? What was the role of my supervisor? Some supervisors will automatically expect to be a co-author. A tactful discussion with your supervisor is usually advisable. My personal feeling is that if the supervisor has significantly contributed to the work then he/she should definitely be an author. (See also §15 on Acknowledgements). A good supervisor will have the wisdom to make the right choice. It is better to err on the side of charity than to lose a friend and probably a promoter of one's own interests and career. Do not forget those who may have played a significant role in making your work possible. Possibly the technician who designed your apparatus and in the process actually contributed important ideas should be added as an author.

6. Order of the Authors Names

This is another great opportunity to lose friendships. Discuss frankly with your co-authors the order in which the authors' names are to appear. If there is no obvious distinguishing reasons for a particular author order then ordering alphabetically can save trouble. Remember if there are more than two authors the paper is likely to be referred to in the literature by the first name *etal*.

7. Which Journal?

You are writing your paper in order to communicate your results and ideas primarily to other workers in your field of study. You want to present your results to as wide an audience as possible. This means giving very careful thought as to the most appropriate journal. The first rule is to avoid journals of limited circulation. The Journal of the Erewhon Institute of Physics might be keen to publish your paper but will anyone read it? Maximum impact is likely to be achieved by publishing in well established journals rather than fringe journals. A good guide is to look at journals that publish significant papers in your area of study, though not in journals that are overly specialised. Resist journals that claim to represent your narrow field to the exclusion of others. I personally favour broadly based international journals to narrowly defined national journals which are read by few. Your reputation as a scientist is likely to be enhanced by publication of your paper in a prestiguous journal.

8. Getting Started

Having decided on the journal you plan to submit your paper go to the library and find an issue that explains the journal's requirements for the preparation of a manuscript. This should give you the address of the Editor, instructions on submission, the style of publication, acceptable word-processors, tell you if they accept electronic submissions etc. Also look at current papers in the journal. This can give you an idea of the final form of manuscripts and journal layout. Most papers will carry a date of submission, check these against the date of publication. This will give you an indication of how long you will have to wait before you see your article in print. Different journals will have different styles for references, some will, or will not, accept colour prints, photos, computer generated graphs etc. Check if the journal offers $\mathcal{T}_{\mathrm{E}}X$, *Latex* or *AMSTEX* macros which can usually be obtained by e-mail. For example, for *Physical Review* papers there is RevTex, for the UK Institute of Physics journals IOPTEX, many mathematical journals AMSTEX macros etc. These macros will allow you to produce a finished manuscript that conforms to the requirements of the journal permitting in many cases more rapid publication. You may also be able to print out a copy of your manuscript in either preprint form or in actual journal format. Note that grammatical styles can vary greatly between different journals. Thus American Institute of Physics (AIP) Journals are likely to scatter commas and other punctuation marks throughout your papers whereas UK journals (IOP) have a much more relaxed approach to punctuation. American journals will expect conformation with Webster's dictionary whereas UK journals will tend to conform to the Oxford dictionary. In general AIP journals are more formal and intolerant of humour than are IOP journals . I would advise against using grammatical packages such as GRAMMATICA, develop your own style and avoid the straitjacket of such packages.

Many people find writing their first paper a traumatic experience and have great difficulty getting started.

The best approach is to sit yourself down and start writing! You'll be surprised how thought patterns start to develop. Until you get your fingers moving nothing will happen. This is the experience of even veteran writers and established novelists.

9. Format of a Paper

In most journals there is a fairly standard format. The first page, often referred to as the *title page*, usually contains the title of the paper, the authors' names and addresses, the abstract, the introduction, the main body of the paper, conclusions, acknowledgements, a list of references, possibly figures, tables, and appendices.

10. Choice of a Title

The choice of a title for your paper is *very* important for two reasons.

(1.) Your readers are busy people they will scan the journal looking for articles that interest them. The first thing they will see is the title of your paper. On that alone they may decide to read, or not to read, your paper.

(2.) Abstracting journals, databases etc will list your title and as a result people may discover your paper while searching a database. You will want them to be able to find *your* paper from the hundreds of thousands of other papers.

Your title should cogently describe your paper and should contain keywords that someone would turn up on a search or would attract the interest of the reader. Look at one of the abstracting journals (e.g. *Physics Abstracts*) that will give you lists of keywords and subject areas. See that appropriate keywords appear in your title.

11. The Addresses

The address of each author should be accurately specified. It is useful to also give the e-mail address of each author, possibly as a footnote. If the address of an author is temporary or involves more than one institution then indicate the permanent address, again this might be given as a footnote.

12. The Abstract

Usually you will write the abstract for your paper after writing the main body of your paper. As with the title, the abstract will be picked up by abstracting journals and will, in many cases, be searchable so it should include keywords. Again, remember the reader is busy, he/she has been attracted by your title and reads the abstract to see what the main points of the paper are and whether it is likely to be worthwhile reading or scanning the whole paper. At each stage you stand to lose readers. Its up to you to maintain your reader's interest.

12. The Introduction

Many authors leave the writing of the introduction to after writing the main body of the paper. Again, great care needs to be taken with the introduction. The reader has decided to read your paper. The introduction should indicate clearly how your new work is related to previously known work and should summarise your main results and achievements. It should be a verbal statement *NOT* a mathematical statement. You must be able to describe in words what you have done. The introduction should be readable by any intelligent person working in the general area of say physics. It should not be directed solely at specialists, that can come later.

13. The Main Body of the Paper

The paper should be given a logical order of presentation and divided into complete selfcontained sections. Before starting to write in detail try to sketch out some sample section headings so as to get the flow of the paper established. Sometimes it is desirable to put into appendices material that while essential to the paper is likely to be distracting to the main thrust of the paper. This might include, for example, the detailed proof of an identity.

Mathematical equations should be numbered and in most cases seperated from the text. I prefer to number almost every equation rather than just a few so that anyone commenting on an equation can refer to it by the equation number.

14. Conclusions

In most cases the paper will end with a set of conclusions and concluding discussion. At this stage one

may summarise the main results, possibly indicating future directions of research.

15. Acknowledgements

This is the place to be generous. One should acknowledge any financial support your work has received by way of scholarships, stipends or research grants. Technical support should be acknowledged, a helpful technician might be acknowledged by name, perhaps the person who wrote the program for the data analysis. If the supervisor is not an author a kind word could be included here. Likewise anyone else who has been of more than normal assistance can be acknowledged. Again AIP journals tend to be rather grudging in acknowledgements.

16. References

Look at a current issue of your prospective journal to see the style of references used. Be fair in referencing all relevant papers. Again, better to be overly generous than mean spirited. Do not raise the wrath of your potential referees by omitting references to their work, if it is relevant. The introduction is a good place to reference previous work in your area.

17. Submitting your Paper

Before submitting read your manuscript carefully, put it down for a couple of days and then re-read it. If you have a spell-checker see if it can find any obvious spelling errors - these may have arisen simply as a mistyping of a word. Have someone else read through your paper - you'll be surprised how often they will find typographical errors that you missed. Try to have your paper as near perfect as possible before submitting it. Your referees will appreciate a tidy coherent manuscript.

Follow the journal's instructions on submitting manuscripts. This you will normally do with a brief accompanying letter to the editor, possibly in the form:-

> I enclose three copies of my/our paper entitled "A light emitting silicon based superlattice for optoelectronics" for consideration for publication in the Journal of Physics C:Condensed Matter. A TEX version of this manuscript is available. Correspondence relating to this paper should be directed to the undersigned.
> Yours sincerely,
> W.H.Y Knott

18. Refereeing

Your paper will be received by the Editor who will normally send you a brief statement acknowledging receipt of your paper and informing you that in due course you will receive a report on the acceptance, or otherwise, of your paper for publication. The Editor will usually send it to two referees who will be asked to comment on the suitability of your paper for publication, reporting back to the Editor who will then send you the referees' reports and their recommendation. Immediate acceptance is relatively rare as is outright rejection so do not be too disappointed if the acceptance is qualified by a request to resubmit after consideration of the referees' reports. Referees are human beings with all such frailities. Keep calm and do not dash off an angry reply - that will almost certainly gaurantee rejection and help noone. Put it down for a day or two and then return to it. In most cases the referees' comments will be helpful. Sometimes the comments will be relatively minor and can be readily attended to and the paper resubmitted with a letter something like:-

> Thankyou for your reports on my paper ""A light emitting silicon based superlattice for optoelectronics". The referees' remarks are appreciated and I have ammended my paper in accord with their suggestions and trust that it is now in a form acceptable for publication.
> Yours sincerely,
> W.H.Y Knott

In some cases the referees may consider your paper is more suited to publication in an alternative journal. In that case you probably made a bad choice of journal and should follow the referees' advice.

In other cases the referees may raise serious questions about the content of your paper. In that case you should consider making a complete revision of your paper and resubmit with possibly a detailed reply to specific questions raised by the referees. Under no account direct abusive remarks at the referees or the Editor.

In still other cases one or more of the referees may make remarks with which you totally disagree. Perhaps

you did not state things clearly and the referee misunderstood you. In that case your readers will probably also misunderstand you. Perhaps the referee has reviewed your paper which was outside his/her sphere of competence. A good referee would return the paper to the Editor and ask that someone more appropriate referee it. Try to accommodate your referees as much as possible. If you feel they are off the mark write a calm non-abusive letter to the Editor explaining your point of view and kindly suggest that another referee be considered. Discuss your problems with your colleagues - you will often be pleasantly surprised how helpful they can be.