Chapter 10

The Art of Scientific Communication

Once you do a piece of research work, you will need to make it known to others, at least to those who work in related areas. The means of doing that is to write it up as a research paper, and to get it published in a reputed peer-reviewed journal. To a lesser degree, presentation in a scientific conference also offers a means of dissemination of the knowledge you created. In this chapter we shall discuss the methods of effective scientific communication, specifically aimed at writing papers for scientific journals.

Different journals have different formats. Some accept only brief papers limited to a certain number of pages. Some journals accept longer submissions, reviews, and expository manuscripts. In this chapter we'll mainly deal with the usual format. The other formats also follow similar guidelines, the specificities may be obtained from the journal's website.

10.1 Before you start writing

Before starting to write, ask yourself:

- *Exactly what information do I wish to present in this paper?* For this, scan your data and graphs to identify the ones that

can be used to tell a wholesome story. All research is nothing but our attempt to answer some *questions* about nature and society. So identify the questions you had, and identify the data, graphs, derivations, simulation results, etc., that help in answering that question.

- *For what specific group of readers am I writing?* A paper may be aimed at a very focused group or to a larger audience; it could be focused on a specific specialization, it could also be accessible to people across disciplines. Select your target audience.

- *What background information can I assume these readers to have?* Every paper has to provide *some* background information in the form of literature survey. How much background information you would provide in the paper, at what level of exposition, depends on the answer to this question.

- *What is the most logical sequence in which I should present the information to the readers?* A paper could present the theory first and then an experiment, or an experiment first and then the theoretical explanation. Choose the proper sequence before you start to write.

Now we come to each component of the paper.

10.2 Title

The title should accurately describe the content of a paper using the fewest possible words (at most ten). Most readers find papers through keyword search, and so if you want to ensure that people looking for certain keywords should see your paper, these words should be included in the title. Once a title shows up through keyword search, one should clearly understand what the paper is all about by reading the title — otherwise he/she will not download the paper. That is why the title is the most important

component of a paper. A good idea is to list out the words that should be included in the title, then to form a few alternative titles by joining them, and then to choose one from the list. In order to make it concise, avoid all superfluous phrases like "A study of ⋯", "Thoughts on ⋯" "Investigations of ⋯", "Observations on ⋯", etc., and words like 'novel', 'powerful', etc. Avoid non-standard abbreviations and acronyms.

A few points to note on the style:

- Capitalize all the nouns, pronouns, adjectives, verbs, adverbs, and subordinating conjunctions (If, Because, That, Which).
- Capitalize abbreviations that are otherwise lowercase (e.g., use DC, not dc or Dc) except for unit abbreviations.
- Articles (a, an, the), coordinating conjunctions (and, but, for, or, nor), and most short prepositions should be in lowercase unless they are the first or last word.
- Prepositions of more than three letters (Before, Through, With, Without, Versus, Among, Under, Between) should be capitalized.

10.3 Abstract

After the title, the second thing that a prospective reader goes through is the abstract. The title and the abstract are openly availabile to everybody, and one does not have to be a member of a library or subscriber of a journal to access these. Most people decide which papers to read by going through the title and abstract. That is why the main purpose of the abstract is help the reader to decide whether to read the paper in its entirety.

Since the reader of the abstract may not be a specialist in the field, it should be self-contained and intelligible in itself, and one should not have to read the paper in order to understand the abstract. An abstract should answer questions like: What have you done? How did you do it? What is new here? Why is

it interesting? What are the ramifications? Do not make inconclusive statements like "in this paper we study ···". Rather make statements in the tone of "we show that ···".

A well prepared abstract should enable the reader to identify the basic content of a document quickly and accurately, and to determine its relevance to the reader's interests. The abstract should also concisely summarize the results and principal conclusions. The abstract must be brief, only one paragraph, not exceeding 250 words or otherwise as prescribed by the journal. Omit all references to the literature and to tables or figures, and omit uncommon abbreviations and acronyms even though they may be defined in the main body of the paper. In case you need to cite some earlier work, give the full reference, like [A. B. Das, Phys. Rev. B, 26, 109 (2006)]—because the abstract has to be self-contained. Do not use displayed equations and expressions.

Read the abstract again and again to locate superfluous words and phrases, and drop them. Write straightforward concise English. Make every word count. But do not omit a's, an's and the's. A good abstract is one where not even a single word can be deleted without diminishing its substance.

10.4 The body of the paper

Excepting short 'Letters', the body of the paper is generally divided into a few sections, starting with an 'Introduction' and ending with a 'Conclusion'. These two are the most important sections in the body of the paper, because most readers read these two before venturing to read the rest of it.

10.5 Introduction

The Introduction section should clearly address the following.

1. *State the problem being addressed in the paper.* From the first paragraph one should get a clear idea of the motivation of

the paper. The first sentence of the Introduction is crucial: it determines the readers initial impression about the whole piece of work.

2. *State what is already known on this issue.* The literature survey should be exhaustive but concise. You should not omit any part of the existing knowledge. Not knowing what has already been found by others is considered to be a discredit. Citing relevant prior work is not optional: It is mandatory. Remember, the reviewer will most probably be from among the people you have cited. Nowadays a lot of means are available through which one can find all the relevant papers—like searching through scholar.google.com, www.arxiv.org, www.webofknowldge.com, etc., using appropriate keywords. The literature survey should be woven like a story of the past investigations on the issue at hand, and the results that have been obtained.

3. *After having told what is known, state what are yet unknown*: State the questions that remain unanswered. These should be phrased like questions (sentences that start with 'what', 'how', 'when', and end with a question mark '?'), not like statements ("in this paper we study the property of $\cdots$").

4. *State what methodology you follow to obtain the answers*: Are you proposing a hypothesis? Are you performing an experiment? Is the work based on numerical simulation? Are you proving a theorem?

5. *Briefly state the main results*: Don't keep the main outcome of the paper to be stated in the 'Conclusions' section. In the Introduction, you should tell the reader what to expect in the paper. State the prime conclusions in the manner of "we find/show that $\cdots$".

6. *Devote a paragraph to outline the structure of the paper*, i.e., what are contained in each section of the paper. You may omit this in brief papers and Letters.

10.6 The middle part of the paper

After the Introduction, your have to describe the background, system description, methods, results, discussion, before coming to the 'Conclusions' section. If the literature survey is too long, it can be included in a separate 'Background' section. Otherwise it should be included in the 'Introduction' section.

The system being studied, its mathematical model, etc., have to be described before going into the actual investigation. You have to clearly state the methodology followed, the assumptions, etc. It you are reporting an experiment, describe the experimental apparatus, parameters used, accuracy achieved, and all such details so that anybody can repeat the experiment. Then state the results and what it implies.

Remember that most readers would jump around: Read the first paragraph of the Introduction, then take a quick look at the figures, read the conclusions, and then decide which parts to focus on. So provide ample landing grounds while the reader jumps around.

10.7 Figures

Many readers sift through the figures to get a glimpse of what is contained in the paper (very few would read the full paper from introduction to conclusion). Liberally use figures to illustrate the concepts and results, because images convey an idea more directly than passages of text. Make each figure along with the caption as self-contained as possible. If the data obtained in field observation or experiment or numerical simulation can be organized into a graph, always do so.

10.7.1 Axis marking

The axes of the graphs should be clearly marked using words. For example, if you are plotting a velocity in one axis, don't just write "v", write "Velocity v (m/s)". Do not label axes with a ratio

of quantities and units. For example, write "Temperature (K)," not "Temperature/K". If there are multiple plots in a graph, use labels on the graphs. Put units in parentheses. Do not label axes only with units. For example, write "Magnetization (A/m)", not just "A/m".

The letters within the figures should be sufficiently large so that after composition (which often involves reduction in size) the letters are of the same size as those in the caption. By default, software like MATLAB, ORIGIN, or GNUPLOT do not produce the labels satisfying this requirement. One has to deliberately set the options such that the letters within the figures are of appropriate size.

10.7.2 Image formats

Images come in two broad formats: raster graphics and vector graphics. Raster graphics formats save an image as a collection of dots while vector graphics formats save a set of coordinates and construct the image by drawing lines and curves. That is why a vector image does not become blocky when enlarged while a raster image does. For this reason, publishers prefer submission of images in a vector graphics format.

In Windows, the raster graphics programs are Paint, Photoshop, etc., and vector graphics programs are Adobe Illlustrator, Visio, Coreldraw, etc. In Linux, a standard raster graphics program is GIMP and a vector graphics program is Xfig. If exported as postscript, a Matlab-generated figure is saved as vector image.

Raster graphics formats come in two categories: lossless (bmp, tiff, pcx, png) and lossy (gif, jpg, etc.). The usual vector graphics formats are ps, eps, and pdf (these formats can also take raster images). If you only have raster graphics programs, produce the figures in sufficiently large size so that it smoothens out when reduced to reproduction size. In that case, make the lines thick, so that they show well even after reduction.

10.7.3 Caption

The figure caption should contain the necessary information:

- What versus what is plotted.
- The meaning of lines drawn with different line-styles or colours.
- What are presented in the subfigures (a), (b) etc.
- The parameter values used.

Write the full word 'versus,' not just 'vs'. Do not repeat in the main body of the paper what has been written in the figure caption.

10.7.4 Colour in figures

Nowadays some journals print in black and white, but put colour images in the online versions. They charge a lot for printing in colour. In such cases use color only if that adds to clarity. Give a lot of importance to how a figure would look in black and white print.

If you send only colour images to the journal and greyscale versions are printed using the same files, make sure line styles are distinguishable. An easy way of checking this is to print the colour images with a black-and-white printer, or to open with any image editing software, and to save as greyscale image.

Since the print will be in black and white, it is a good idea not to produce graphs in colour unless it is really necessary. Draw the lines in black, in different line styles (dashed, dash-dot etc.). They reproduce better in print than different shades of grey.

If B&W images are printed and colour images are to be put in the online versions, write "colour online" in the caption. That way, someone reading the print version will know that better clarity is available in the online version.

10.7.5 File size

Make the file size as small as possible. Vector graphics normally produce small file size. Unless you take care, graphs produced by some software produce monstrously large file size. Most of the information in the large file size are simply junk, like printer-specific font information. Sometimes a large filesize is produced because you are trying to plot a far larger number of points than the resolution of the screen or the printer.

Produce the graphics judiciously. Large file sizes of the figures will make the file size of the paper large. People with slower internet connection will have difficulty in downloading such papers, and you may lose prospective readers. Many people nowadays read papers on their mobile phones, and large file sizes hinder such access.

10.8 Citing references

While citing references in text, place these in square brackets, inside the punctuation. Grammatically, they may be treated as if they were footnote numbers, e.g., as shown by Agarwal [4], [5]; as mentioned earlier [2], [4]–[7], [9]; Narlikar [4] and Bose and Mukherjee [5]; Ramaswamy et al. [7] or as nouns: as demonstrated in [3]; according to [4] and [6]–[9]. Use 'et al.' when there are three or more authors.

In the Harvard style, references cited in the text should be placed within square brackets and stated as [surname of author(s), year of publication], e.g., [Gadagkar, 1994], [Gupta & Saini, 1969] and, for three or more authors, as [Singh et al., 2004]. If the reference reads as part of the sentence, the square brackets enclose only the year of publication, e.g., "According to McDonald [2009], ⋯"

Different journals adopt different styles of citation. You have to check the "Authors' Guide" of that specific journal to find out what style they use.

This becomes a problem if a paper was produced for one journal and has to be sent to another. LaTeX offers simple solution to this problem: Each journal has its own style file, downloadable from their website. You just have to call that file and LaTeX would automatically compose according to the specific journal's specific style.

10.9 Conclusion

Typical functions of this section are:

- Summing up
- A statement of the conclusions coming out of the work
- A statement outlining the implications and recommendations (if any)
- If the work raises new questions, point to them
- Graceful termination.

After the Introduction, the 'Conclusions' section is probably the most read. Some readers even jump from an Abstract to the Conclusions. So do not assume that readers know definitions given in the body of your text. Summarize your key results without repeating phrases or sentences that have appeared in the abstract or previous text.

The conclusions should be consistent with what the reader expects from the Introduction. But do not repeat what has been said in the Introduction.

10.10 Acknowledgement

It is customary to include an 'Acknowledgement' section in a paper. In this section,

- Acknowledge all sources of financial support.

- Acknowledge all of those you had fruitful discussion with in course of the work or preparation of the paper.
- If a Lab Assistant or technician provided more than routine service in performing an experiment, acknowledge him/her.

If the work (or a part of it) has been financially supported by a funding agency through a project, you should acknowledge that. If a student's stipend has come from a funding agency like the CSIR, DST or UGC, that should also count as financial support for the work and should be duly acknowledged.

The reviewers of the paper are anonymous. It is meaningless to acknowledge them.

10.11 References

There are many styles of writing the references. For example, the same paper can be cited in the following ways.

[1] E. N. Lorenz. Deterministic Nonperiodic Flow. Journal of the Atmospheric Sciences, 20(2):130–141, 1963.

[2] E. N. Lorenz, "Deterministic nonperiodic flow," Journal of the Atmospheric Sciences, vol. 20, no. 2, pp. 130–141, 1963.

[3] E. N. Lorenz, J. Atmos. Sc., 20, 130 (1963).

Each journal follows a particular style, and you have to find it from the journal's webpage or by looking at the papers published in that journal. It becomes a problem if a paper is prepared for a journal and due to some reason has to be submitted to a different journal. The specific journal referencing style has to be freshly inserted.

The solution to this problem in LaTeX is to put all the bibliograhic database in a single file with extension '.bib'. This has to be done in a specific format. For example the entry for an article would be like:

```
@article(lorenz63,
author={E. N. Lorenz},
title={Deterministic Nonperiodic Flow},
journal={Journal of the Atmospheric Sciences},
year={1963},
volume={20},
number={2},
pages={130-141})
```

The reference is then cited in the main (.tex) file as

```
as shown by \cite{lorenz63}.
```

Where the references are to be inserted, just write the two lines

```
\bibliographystyle{unsrt}
\bibliography{filename}
```

Here "unsrt" identifies a specific referencing style (which has to be replaced by the name of the journal's style) and "filename.bib" is the file in which the bibligraphic database is stored.

When bibtex is run on the file, a new file with extension ".bbl" will be created. It will have all the information regarding the references cited in that particular paper. When latex is run again, the reference will be automatically inserted at the appropriate place, in the style specific to the publisher. Each journal has a LaTeX style file (a .bst file), downloadable from the journal's webpage.

10.12 Revising the manuscript

After the first draft is prepared, ask

- Have I included all the information necessary to convey my message?
- Have I eliminated all superfluous material?

- Have I given proper emphasis to important ideas, and subordinated those of lesser importance?
- Is the development of the subject matter complete and logical, free of gaps and discontinuities?
- Have I been as quantitative as possible in presenting the material?
- Have I made the best use of tables and figures, and are they well designed?
- Is the material I presented free from subjective judgments and personal preconceptions?
- Are the information provided sufficient for anybody to repeat the work and check the results?
- Are the facts I have presented adequate and sufficient to support the conclusions I intend to draw?

Based on the outcome of these queries, revise the paper repeatedly.

10.13 Writing a thesis

All the points mentioned above in the context of writing a paper, also apply to writing a master's or PhD thesis. The only major difference is that while the space available for a paper is limited, there is no such size limitation in a thesis. A thesis is normally of 150-300 pages in length. This necessitates the following changes in form.

While the abstract of a paper contains just one paragraph containing 150–250 words, the abstract of a thesis can be 2-3 pages long, and paragraph breaks are allowed. The content and stylistics of writing the abstract, however, remain the same.

The units in a paper are the sections, while those in a thesis are the chapters. Thus, the first chapter is normally the Introduction. It addresses exactly the same issues as discussed in the

context of paper writing in Section 10.5, organized as sections in the chapter. The usual sections in the Introduction chapter are as follows.

Introduction (yes, there is an 'Introduction' section within the 'Introduction' chapter). Here state the overall area of the paper and problems being addressed (without going into the details).

Theoretical background. Here present the background theory in the field, so that someone who does not know the details can be primed up to understand what comes in the rest of the thesis.

Literature survey. Here you discuss what is known on the subject. The literature survey in a thesis has to be very elaborate. It essentially reflects what you have studied in course of the PhD work. A PhD thesis normally contains more than 100 references and the essential contribution of each paper has to be discussed. Do *not* copy and paste from the abstracts of these papers to state what these papers have done. Write in your own language, and weave it as a story of how knowledge in this field developed step by step, with contribution from many people.

Scope of the present work. Here state the gaps in the present knowledge: the questions that have remained unanswered. Then state how you have tried to answer these questions, i.e., the methodology you have followed.

Organization of the thesis. Here you discuss what is contained in each chapter. In each one, state the question you are addressing, the methodology followed, and briefly state the main results.

The subsequent chapters would essentially contain contributions of the author. If papers have been published, a natural

tendency is to copy and paste the papers verbatim. Avoid that practice. While writing each paper, you had filtered out the results, graphs and tables, and included only those which are essential for that particular paper. In the paper, the scope of explanation is also very limited. In the mathematical work one usually jumps steps, expecting that the reader would re-do the calculations to figure out the missing steps. Since the thesis does not have page limitation, include much more elaborate explanation of the concepts, include a larger number of graphs and tables, and the mathematics should show all the steps.

Each chapter should have an 'Introduction' and a 'Conclusion' section. In the 'Introduction' section, state the issues dealt with in that chapter. In the 'Conclusion' section, state the conclusions out of the work reported in that chapter. Even though you have done an elaborate literature survey in the first chapter, place the work of each chapter in the background of the available knowledge. For this purpose, cite the same papers wherever needed.

Finally there has to be a 'Conclusions' chapter. In this chapter again state the conclusions stated in the earlier chapters, but do not copy and paste. Write afresh the overall conclusions coming out of the whole thesis. This chapter should also have a section 'Scope of future work', in which you state what further possibilities of investigation are opened up through your work.

A PhD student also has to submit a 'Synopsis' of the thesis. The main purpose of the synopsis is to find examiners of the thesis. The Institute or University requests a few eminent researchers in the field to examine the thesis, and the prospective examiner has to have some material in hand to take the decision.

The synopsis has to be limited to about 10 pages, and its purpose should be to arouse interest of the prospective examiners. It should contain mainly the points outlined in Section 10.5, but may also contain the key figures and tables that embody your principal contributions.

10.14 Text stylistics

In this section we outline a few desirable forms of text stylistics in scientific communication—that should be used both for writing papers as well as thesis.

10.14.1 Point of View and Voice

Do not use the first person point of view ("I studied ⋯"). First person is generally not used unless the writer is a senior scholar who has earned some credibility to speak as an expert in the field.

You should use the third person point of view ("The study showed ⋯") unless you are co-authoring a paper with at least one other person, in which case you can use "we" ("Our finding included ⋯"). In general, you should foreground the research and not the researchers.

Use of active voice is particularly important in experimental reports ("We conducted an experiment ⋯").

Use active verbs whenever possible. Writings that overly use passive verbs (is, was, has, have, had) are boring to read and almost always results in more words than necessary to say the same thing. For example,
ACTIVE: "the mouse consumed oxygen at a higher rate ⋯"
PASSIVE: "oxygen was consumed by the mouse at a higher rate ⋯" The clarity and effectiveness of your writing will improve dramatically as you increase the use of the active voice.

However, passive voice is recommended in some situations:

1. When it is more important to draw our attention to the person or thing acted upon: "The mosquito larvae were apparently killed by an infection".

2. When the actor in the situation is not important: "The aurora borealis can be observed in the early morning hours".

3. Instead of writing "I poured 20 cc of acid into the beaker," you should write "Twenty cc of acid was poured into the beaker."

10.14.2 Sentence structure

There are some recommended structures of sentences in scientific writing.

1. If the subject and its related verb are separated from one another by a lot of words, the reader finds it difficult to figure out what the subject is doing. Worse, the reader's mind keeps looking for a closure (what is the subject doing?) and tends to ignore the material that come in between. So, a grammatical subject should be followed by its verb as soon as possible.

2. Every sentence has a 'topic position' and a 'stress position'. The reader normally expects to find what the sentence is all about at the beginning of the sentence. This is the 'topic position'. The ending of the sentence automatically gets stress in the reader's mind. This is the 'stress position'.

3. Place any new information in the stress position. If you want to emphasize something—some character or property of an object—that you want the reader to remember when he reads on, place it at the end of a sentence.

4. The beginning of the sentence should be occupied by a subject about which you want to say something. That subject, in turn, should come from what you have mentioned in the earlier sentences in their stress positions. This way each sentence will be linked with what you have said already, and will form the background for what you want to say later.

   As an example, consider the sentence:

   Liquid helium, when contained in a thermally insulated dewar and cooled to 2.17K, displays the phenomenon of super-fluidity.

The sentence is grammatically correct. However, after reading it once you will notice that your mind has not recorded the

condition that gives rise to superfluidity. This is because, after you have read the subject "Liquid Helium", your mind looks for its closure (what it does) and finds it when it encounters the word "displays". This style of construction, though grammatically correct, confuses the reader. So you should place the subject and its verb close to each other. One way of doing that is:

> Liquid helium displays the phenomenon of super-fluidity when contained in a thermally insulated dewar and cooled to 2.17K.

Now, in the original sentence the topic position is occupied by "liquid helium" and the stress position is occupied by "super-fluidity". But in the revised sentence, "super-fluidity" is not in the stress position. Instead, the condition that gives rise to superfluidity has now assumed the stress position. What you want to stress in the sentence is your decision. If it is the information about the condition that you want to convey, this should be the proper construction of the sentence. But if you really want to stress the phenomenon superfluidity, the proper construction should be

> When contained in a thermally insulated dewar and cooled to 2.17K, liquid helium displays the phenomenon of super-fluidity.

In the former case the reader's mind would expect this sentence to be followed up by more detailed consideration of the condition while in the second case it will expect a more detailed discussion on superfluidity.

This way, weave your narrative into a story-line. The art of writing a good paper is basically to narrate the story of your own investigation to find an answer to a question you have in your mind. Tell it in such a way that the reader can easily relate it to the existing knowledge, can follow your line of reasoning, can understand your experimental set-up or mathematicaly modeling,

can see clearly how your results add to human knowledge, and can agree with your conclusions.

10.14.3 Hyphen, en-dash, and em-dash

These three are denoted by different lengths of a horizontal line, and are used in different contexts. In MSWord, these are available in the list of special characters.

The shortest one is the hyphen. Use hyphen only when joining separate words, as in "zero-field-cooled magnetization".

The en-dash is a line of the width of the letter 'n', and represents the words "to", "through", or "and". Use it between page numbers (e.g., pp. 5–10), reference numbers (e.g., [5]–[10]), figure citations, (e.g., Figs. 2–4), academic years (e.g., 1996–1999), proper nouns (Bose–Einstein theory), a range of values (e.g., 10–20 cm), or for opposites (e.g., in–out). Also use the en-dash in chemical abbreviations such as Ni–Al–Si. In LaTeX it is written with two consecutive hyphens (minus signs).

The em-dash is a line of the width of the letter 'm', and is used to highlight a phrase in a sentence that could possibly be placed inside a bracket. For example, one could write "An example of a type II supernova is SN1987A which occurred in the Large Magellanic Cloud—a smaller galaxy satellite to our Milky Way galaxy—in the year 1987". In LaTeX it is written with three consecutive hyphens.

10.14.4 Some common mistakes

There are some language errors common among Indian writers. Be careful about these.

- The word 'data' is plural, not singular. So never write or say 'datas'.
- Be aware of the different meanings of the homophones 'affect' and 'effect', 'complement' and 'compliment', 'discreet' and 'discrete', 'principal' and 'principle'.

- The prefix 'non' is not a word; it should be joined to the word it modifies, usually without a hyphen (like 'nonlinear').
- There is no period after the 'et' in the Latin abbreviation 'et al.' which means 'and others'. The abbreviation 'i.e.' means 'that is', and the abbreviation 'e.g.' means 'for example'.
- Use a zero before decimal points: '0.25', not '.25'.
- Do not write '&' to mean 'and' (except in often-used expressions like 'S&T').
- Do not use 's' in the plurals of units of measure (write 35 cm, not 35 cms). Plurals of years (e.g., 1990s) do not have the apostrophe. When you have to write plural of a mathematical quantity, use apostrophe (e.g., x's).
- Note these singular and plural forms: criterion, criteria; medium, media; phenomenon, phenomena.
- Do not use *however* or its synonyms twice in one paragraph, because changing the direction of an argument twice in one paragraph annoy readers.
- Avoid using contractions in formal writing: for example, 'don't' should be 'do not' and 'isn't' should be 'is not,' etc. But 'can not' is generally joined into 'cannot'.

Students are often confused in the use of the following phrases:

Owing to or due to? The rule is: 'owing to' always has a comma, 'due to' never does. Example: The larvae were killed, owing to an infection. The death of the larvae was due to an infection. Note that 'due to' is an adjective modifier and must be directly related to a noun, not to a concept or idea.

Which or that? The rule is: 'which' always follows a comma (and a pause), but 'that' never does. "The paper by Kumar and Singh, which was published in Physical Review Letters, has

received 150 citations". "The paper by Kumar and Singh that was published in Physical Review Letters, has received 150 citations".

Compare with, compare to – *Compare with* means to examine differences and similarities; *compare to* means to represent as similar. "One may conclude that the body weight of Indian sparrows *compares to* that of European ones, but to do that, one must first *compare* the body weight of Indian sparrows *with* that of European sparrows".

Correlated with, correlated to – Although things may be related *to* one another, things are correlated *with* one another.

Different from, different than – It is a common mistake to use the phrase 'different than'. *Different from* is the right usage. Also, one thing differs from another, although you may differ with your friends.

10.14.5 Fonts in equations

The letters inside mathematical equations and expressions should in italic. Use italic when writing a mathematical variable inside the text (to distinguish it from normal text), e.g., "let x be a variable and p be a parameter".

Function names and abbreviations (like sin, cos, tanh, lim, log etc.) will be in roman (not italic).

Units (Hz, F, A, V, etc.) should be in roman.

Vectors and matrices should be in boldface.

Subscripts with more than one letter should not be in italic.

10.14.6 Fonts in text

Do *not* use more than one font family (times and arial etc.) in a single document.

To emphasize any part of text, use italic. Do *not* use boldface. Use boldface only in section headings.

10.15 The final words

Prof. Harry Swinney of the University of Texas at Austin, USA, has the following advice on rounding up a paper:

"Become your own critic. Read the text out loud either alone or with another person to check the flow of sentences and to find ambiguous or irrelevant statements. Ask colleagues and friends to critique your manuscript, and volunteer to critique theirs. The most helpful critics are often those unfamiliar with the subject matter."

"Writers tend to become attached to their text and reluctant to make revisions. Listen carefully to the questions your readers raise, and respond by revising your manuscript rather than becoming defensive."

"Prune off material not essential for your story. The longer a paper, the fewer readers it will have. Delete words, phrases, sentences, paragraphs, figures, tables, and sections that are not necessary. Lengthy details can go into an appendix or supplementary information."

"Finally, give the preparation of a manuscript an effort comparable to that put into the experiment, computations, and analysis. Working through the logic of the arguments is an essential part of the creative process and often leads to new insights. A well written paper will garner the attention that the research deserves, while an ingenious result presented poorly may go unnoticed."