How to Write a Scientific Paper*

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科学论文写作*

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What is a scientific paper? A paper is an organized description of hypotheses, data and conclusions, intended to instruct the reader. Papers are a central part of research. If your research does not generate papers, it might just as well not have been done. “Interesting and unpublished” is equivalent to “non-existent.”

什么是科技论文？科技论文是集假说、数据和结论为一体的概括性描述，以此向读者论述。论文是研究工作的中心部分。如果你的研究没有写成论文，也就等同于没有做研究。有意义但没有发表，等同于不存在。

Realize that your objective in research is to formulate and test hypotheses, to draw conclusions from these tests, and to teach these conclusions to others. Your objective is not to “collect data.”

要意识到研究的目的是为了形成并证实假说，从一些测试中得出结论，并把结论传授给别人。你的研究目的不是简单的收集数据。

A paper is not just an archival device for storing a completed research program, it is also a structure for planning your research in progress. If you clearly understand the purpose and form of a paper, it can be immensely useful to you in organizing and conducting your research. A good outline for the paper is also a good plan for the research program. You should write and rewrite these plans/outlines throughout the course of the research. At the beginning, you will have mostly plan; at the end, mostly outline. The continuous effort to understand, analyze, summarize, and reformulate hypotheses on paper will be immensely more efficient for you than a process in which you collect data and only start to organize them when their collection is “complete.”

一篇论文并不仅仅是收集已经得到的研究结果，它也有助于形成进一步的研究工作的框架。如果明确了论文的目的，这对 于计划开展你的研究工作有很大益处。好的文章提要也是研究工作的好计划，在研究的过程中，应该反复修改这些计划或提要。研究工作开始时，应有完善的计划；工作结束时，应充分的总结。最有效率的做法是及时的理解，分析，总结，形成假说； 而不是等到完成时才开始收集和整理数据。

The reason for outlines. I emphasize the central place of an outline in writing papers, preparing seminars, and planning research. I especially believe that for you, and for me, it is most efficient to write papers from outlines. An outline is a written plan of the organization of a paper, including the data on which it rests. You should, in fact, think of an outline as a carefully organized and presented set of data, with attendant objectives, hypotheses and conclusions, rather than an outline of text.

为什么要写提纲？我在这里要强调提纲在论文写作，准备报告以及研究计划中的重要作用。我尤其相信按照提纲进 行写作对我们大家都是最有效的方法。提纲是一篇论文的行文计划，应该包括论文所依靠的数据。事实上，提纲不仅仅是列出各段的内容，而是按照目的，假说，结论来精心组织数据。

An outline itself contains little text. If you and I can agree on the details of the outline (that is, on the data and organization), the supporting text can be assembled fairly easily. If we do not agree on the outline, any text is useless. Much of the time in writing a paper goes into the text; most of the thought goes into the organization of the data and into the analysis. It can be relatively efficient to go through several (even many) cycles of an outline before beginning to write text; writing many versions of the full text of a paper is slow.

提纲本身应该文字简练。如果大家都同意提纲中的细节部分，那么正文组织起来就更容易。在我们就提纲达成一致以前，写正文是没有意义的。写文章时，大部份时间花在写正文上；而大部份思考是用在整理和分析数据。在动笔前，详细讨论几遍写作提纲会提高写作效率；写很多遍正文反倒很慢。

All the writing that I do - papers, reports, proposals (and, of course, slides for seminars)- I do from outlines. I urge you to learn how to use them as well.

我写的所有文章，包括论文，报告，建议（当然还有讨论会的胶片）都从提纲开始。我也希望你们能学会使用它。

How should you construct an outline? The classical approach is to start with a blank piece of paper, and write down, in any order, all important ideas that occur to you concerning the paper. Ask yourself the obvious questions: “Why did I do this work?” “What does it mean?”“What hypothesis did I mean to test?”“What ones did I actually test?”“What were the results?”“Did the work yield a new method or compound? What?”“What measurements did I make?”“What compounds? How were they characterized?” Sketch possible equations, figures, and schemes. It is essential to try to get the major ideas written down. If you start the research to test one hypothesis, and decide, when you see what you have, that the data really seem to test some other hypothesis better, don't worry. Write them both down, and pick the best combinations of hypotheses, objectives and data. Often the objectives of a paper when it is finished are different from those used to justify starting the work. Much of good science is opportunistic and revisionist.

你应该如何起草你的提要？最经典的方法就是找一页空白的纸，以任何顺序，写下与这篇文章有关的所有重要观点。自问一 些显而易见的问题：为什么我要做这项工作？它意味着什么？我要验证哪些假设？我究竟验证了哪些假设？结果如何？这项工作产生了新方法或新物质吗？都是什么？我都做了那些测试？什么化合物？它们是如何表征的？展示相关的方程，图表和示意图。试着写出主要的观点。如果你的研究开始是为证实一个假设，然而当你发现你有的数据仿佛真的可以更好地验 证其它的假设时，你也不必担心。把它们两者都写出来，去选择假设，目的和数据的最佳组合。时常，当一篇文章完成时，它的目的和开始时是不同的。许多好的科 学来自机遇和反复修正。

When you have written down what you can, start with another piece of paper and try to organize the jumble of the first one. Sort all of your ideas into three major heaps (A-C)

当你已经写下你能写的，再拿出一页纸，试着草拟一份提纲。将你的观点分成三大类（见A,B,C）

A) Introduction

Why did I do the work? What were the central motivations and hypotheses?

A）引言

为什么我要做这件工作，主要的目的和假设是什么？

B) Results and Discussion

What were the results? How were compounds made and characterized? What was measured?

B）结果和讨论

结果是什么？化合物是怎样合成与表征的？测试方法是什么？

C) Conclusions

What does it all mean? What hypotheses were proved or disproved? What did I learn? Why does it make a difference?

C）结论

所有这一切意味着什么？证实或否定了什么假设？我学到了什么？结果为什么与众不同？

Next, take each of these sections, and organize it on yet finer scale. Concentrate on organizing the data. Construct figures, tables, and schemes to present the data as clearly and compactly as possible. This process can be slow - I may sketch a figure 5-10 times in different ways, trying to decide how it is most clear (and looks best aesthetically).

接下来，把每一部分再仔细组织。尤其是要集中整理数据。要尽可能把数据以清晰、紧凑的图表来展示。这个过程也许会慢些。我可能要用5-10次，而且是以不同的方式，来构思一张图，以便决定怎样它才最清楚（而且看上去更加美观）。

Finally, put everything—outline of sections, tables, sketches of figures, equations - in good order.

最后，把所有这些—内容的提纲、表格、草图、方程式，排好顺序。

When you are satisfied that you have included all the data (or that you know what additional data you intend to collect), and have a plausible organization, give the outline to me. Simply indicate where missing data will go, how you think (hypothesize) they will look, and how you will interpret them if your hypothesis is correct. I will take this outline, add my opinions, suggest changes, and return it to you. It usually takes 4-5 repeated attempts (often with additional experiments) to agree on an outline. When we have agreed, the data are usually in (or close to) final form (that is, the tables, figures, etc., in the outline will be the tables, figures,…in the paper.)

当你已经囊括了所有的数据（或者 你明确知道你还需要收集哪些额外的数据），有了一个合理的构架，你对这些都感到满意时，将大纲交给我。简要地标明哪些地方还缺数据，你认为（或推测）这些 数据大概是什么样。如果你的推测是正确的，你将如何去解释它。拿到你的大纲后，我将把我的观点，建议反馈给你。一般，我们需要四或五个来回才能达成一致（中间经常还需要补做一些实验）。在我们的意见一致后，所有的数据通常以最终（或接近最终的）形式确定下来（也就是说，在提纲中的表格，图表等最终将成为 文章中的表格，图表）。

You can then start writing, with some assurance that much of your prose will be used.

然后，你就可以开始动笔写，注意你写的这些大多将用于正文。

The key to efficient use of your and my time is that we start exchanging outlines and proposals as early in a project as possible. Do not, under any circumstances, wait until the collection of data is “complete” before starting to write an outline. No project is ever complete, and it saves enormous effort and much time to propose a plausible paper and outline as soon as you see the basic structure of a project. Even if we decide to do significant additional work before seriously organizing a paper, the effort of writing an outline will have helped to guide the research.

合理使用我们的时间的关键是，我们应尽可能早地交换提纲和建议。在任何情况下，都不要等到你已经收集“全”了数据之后才开始动 笔写提纲。研究是永无止境的。当你看到你的结果初具雏形时，就要立即开始准备构思文章和提纲，这将节省你很多的精力和时间。即便在认真组织成文前，我们已 经决定补做重要的其他实验，试着写一个提纲也一定对研究有指导意义。

The outline

提纲

What should an outline contain?

提纲需要包括哪些内容？

Title:

Authors:

Abstract: Do not write an abstract. That can be done when the paper is complete.

标题：

作者：

摘要：不要着急写摘要，可以等文章写完后再写。

Introduction: The first paragraph or two should be written out completely. Pay particular attention to the opening sentence. Ideally, it should state concisely the objective of the work, and indicate why this objective is important.

引言：文章的第1或2段应该完全用来写引言。要特别注意写好开头一句话。最好是简洁地陈述工作的目的，并指明该工作为什么重要。

In general, the Introduction should have these elements:

The objectives of the work.

The justification for these objectives: Why is the work important?

Background: Who else has done what? How? What have we done previously?

Guidance to the reader. What should the reader watch for in the paper? What are the interesting high points? What strategy did we use?

一般而言，引言应该包含以下几个要素：

工作目的。

对工作目的评价：该工作为什么很重要？

工作背景：谁做了什么工作？做得怎么样？以前我们做了哪些工作？

导读：读者应该注意该文章的哪些方面？有意义的要点有哪些？我们用到了哪些策略？

Summary conclusion. What should the reader expect as conclusion? In advanced versions of the outline, you should also include all the sections that will go in the Experimental section (at this point, just as paragraph subheadings).

总结结论。读者期望什么样的结论呢？在提纲的前几个版本中，你应该包括实验部分中涉及到的所有内容。（在这一点上，就像是段落的副标题）。

Results and Discussion. The results and discussion are usually combined. This section should be organized according to major topics. The separate parts should have subheadings in boldface to make this organization clear, and to help the reader scan through the final text to find the parts that interest him or her. The following list includes examples of the phrases that might plausibly serve as section headings:

结果和讨论。通常，结论和讨论是合在一起的。这一部分应根据主题来进行组织。分段应有黑体字的副标题，目的是使文章更有条理，能帮助读者清楚地通览全文，并找到他们感兴趣的内容。下面列举一些适合作副标题的短语：

Synthesis of Alkane Thiols

烷基硫醇的合成

Characterization of Monolayers

单层膜的表征

Absolute Configuration of the Vicinal Diol Unit

邻二醇单元的绝对构像

Hysteresis Correlates with Roughness of the Surface

滞后现象与表面粗糙度的关系

Dependence of the Rate Constant on Temperature

温度对速率常数的影响

The Rate of Self-Exchange Decreases with the Polarity of the Solvent

自交换速率随溶剂极化度而降低

Try to make these section headings as specific and information-rich as possible. For example, the phrase “The Rate of Self-Exchange Decreases with The Polarity of The Solvent” is obviously longer than “Measurement of Rates,” but much more useful to the reader. In general, try to cover the major common points:

尽可能使副标题具体并且内容丰富。例如，“The Rate of Self-Exchange Decreases with The Polarity of The Solvent”

这个短语明显比“Measurement of Rates”长，但是对读者更有帮助。一般来说，尽量概括该段落的共同点。

Synthesis of starting materials

初始材料的合成

Characterization of products

产物的表征

Methods of characterization

表征方法

Methods of measurement

测量方法

Results (rate constants, contact angles, whatever)

结果（速率常数，接触角，其它）

In the outline, do not write any significant amount of text, but get all the data in their proper place: any text should simply indicate what will go in that section.

Section Headings

Figures (with captions)

Schemes (with captions and footnotes)

Equations

Tables (correctly formatted)

在提纲中，不要罗列大量的正文内容，而是要给出数据应放的合适位置：任何正文应该简明地指出那段中包括了什么数据。

副标题

图表（附说明）

示意图（附说明和注解）

方程

表格（正确格式化的）

Remember to think of a paper as a collection of experimental results, summarized as clearly and economically as possible in figures, tables, equations, and schemes. The text in the paper serves just to explain the data, and is secondary. The more information that can be compressed into tables, equations, etc., the shorter and more readable the paper will be.

记住把文章看作实验结果的集合，并尽可能清晰和简洁地总结在图表，表格，方程和示意图中。论文中的正文是为解释数据服务的，因而它是次要的。可以被压缩进表格，方程等的信息越多，文章越短，越易读。

Conclusion. In the outline, summarize the conclusions of the paper as a list of short phrases or sentences. Do not repeat what is in the Results section, unless special emphasis is needed. The Conclusions section should be just that, and not a summary. It should add a new, higher level of analysis, and should indicate explicitly the significance of the work.

结论。在提纲里，总结论文中的结论应是由一些简短的短语或句子组成。除非是为了特殊的强调，一般不要重复在结果部分已经有的结论。结论部分应该是像上面说的那样，而不仅仅只是一个总结。它应该增加新的，更高层次的分析，并且应该明确地指出这项工作的意义。

Experimental. Include, in the correct order to correspond to the order in the Results section, all of the paragraph subheadings of the Experimental section.

实验部分。包括所有实验部分的副标题，顺序与结果部分要相对应。

In summary:

总结：

-Start writing possible outlines for papers early in a project. Do not wait until the “end”. The end may never come.

在一个项目开始时，就应该着手去写可能的论文提纲，而不要等到论文结束的时候。研究可能永远没有结尾可言。

-Organize the outline and the paper around easily assimilated data - tables, equations, figures, schemes - rather than around text.

整理提纲和论文要围绕易于接受的数据—表格，方程式，图表，示意图，而不是围绕正文。

-Organize in order of importance, not in chronological order. An important detail in writing paper concerns the weight to be given to topics. Neophytes often organize a paper in terms of chronology: that is, they recount their experimental program, starting with their cherished initial failures and leading up to a climactic successful finale. This approach is completely wrong. Start with the most important results, and put the secondary results later, if at all. The reader usually does not care how you arrived at your big results, only what they are. Shorter papers are easier to read than longer ones.

不是按照时间顺序，而应按重要性来整理。论文写作的一个重要细节是要考虑各部分的权重。新手常常按照时间顺序来写论文：他们常常从珍爱的开始时的失败写起，直到最后的成功来 叙述实验过程。这种方法是完全错误的。应该从最重要的结果写起，然后是较重要的结果。读者们通常不关心你是怎么得到的结果，而只关心结果是什么。短文章比长文章更易读。

Some Points of English Style

英文文体上的一些要点：

1) Do not use nouns as adjectives:

不要将名词误用为副词：

不合适的：正确的：

ATP formation formation of ATP

生成ATP

reaction product product of the reaction

反应产物

2) The word “this” must always be followed by a noun, so that its reference is explicit

在“this”后面必须接名词，这样“this”所指的对象就会更加清楚。

不合适的：正确的：

this is a fast reaction this reaction is fast

这是一个快反应

this leads us to conclude this observation leads us to conclude

这个观察结果使我们推断出

3) Describe experimental results uniformly in the past tense.

描述实验结果一律要用过去时态。

不合适的：正确的：

Addition of water gives product addition of water gave product

加水后生成产物

4) Use the active voice whenever possible.

尽可能使用主动语态。

不合适的：正确的：

It was observed that the solution turned red. The solution turned red Or We observed that the solution turned red.

溶液变成了红色。或，我们观察到溶液变成了红色。

5) Complete all comparisons.

所有的比较都应该是完整的。

不合适的：正确的：

The yield was higher using bromine The yield was higher using bromine than chlorine.

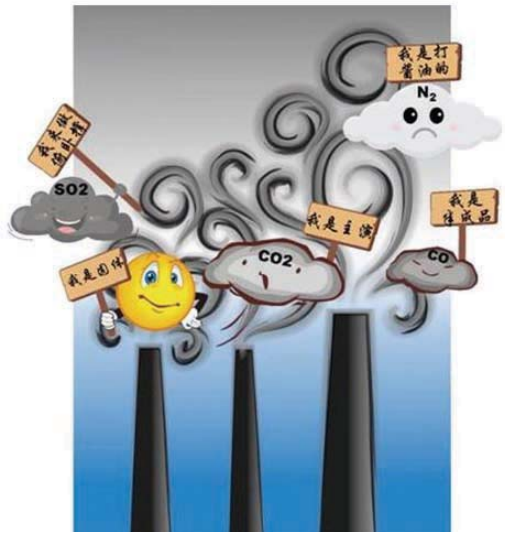
用溴比用氯时产出率高。

6) Type all papers double-spaced (not single-or one-and-a-half spaced), and leave 1 space after colons, commas, and after periods at the end of sentences. Leave generous margins. (generally, 1.25” on both sides & top & bottom).

打文章时，要使用两倍行距（不用一倍或一倍半）。冒号、逗号和句末的句号后要空一格。要留出足够的页边空间。（通常，在文章两侧、页首和页尾留出1.25英寸的空间）

（转自网络 有删改）

二氧化碳的全球通缉令



谁是那个最著名的全球通缉犯？谁现在是人人喊打必欲除之而后快？谁让人类恨得牙根痒痒想要将它掐死在襁褓之中？本.拉登？那你就孤陋寡闻了，现如今让全世界超越了种族与地域的界限而同仇敌忾的，是二氧化碳。

随着越来越多的证据表明是人类活动排放出的二氧化碳造成了气候变化，各国政府、研究机构、公益组织都在设法减少二氧化碳的排放，包括发展风电、水电、太阳能等排放二氧化碳少的能源项目；研究更清洁的技术设备；号召大众选择更简单的生活方式等等。除了这些将敌人消灭在摇篮里的方法，还有一类广受瞩目的技术-碳捕获与封存（Carbon Capture and Storage，简称CCS），寄希望于将已经或即将排出的二氧化碳捉拿归案，以免它们出去惹是生非。

人类社会经过三十余年的研究与实践，现在发展出了追捕二氧化碳的三步曲：围剿,学名“捕集”；押运；和永久羁押，专家叫“封存”。

捕集-挑肥的地方下网

就像捕鱼要去鱼群活动的范围一样，全球的火力发电站是排放二氧化碳最密集的地方，占到了人类活动排放二氧化碳总量的四分之一，研究者们通常都在这里下手。火力发电站的化石燃料，包括石油、煤、天然气等，燃烧后排放出混杂着氮气、二氧化碳、二氧化硫、一氧化碳和各种粉尘杂质的烟气。

这些尾气中，个别的不是污染物，比如氮气，完全是随着燃烧充氧的过程混进工厂的，处理尾气的设备奈何它不得，也不需要奈何它；大部分虽然没有温室效应，但是污染物，比如二氧化硫，危害植物叶片和人类呼吸系统，还造成酸雨，一定要用脱硫装置处理掉，当然，这些技术目前已经很成熟了；再比如一氧化碳，是燃烧过程中氧供应不充足产生的副产品，但对生物体的毒害作用很大，还是光化学烟雾的重要参与者，想解决它，就需要在燃烧阶段下点功夫，多赶点氧气进去工作；另外还有一些不是气体的东西也随着气流逃了出来，比如像煤里的硫化亚铁