



Writing a Scientific Paper in English

Part 1: Structure and Content

Caitriana Nicholson

Editor, Chinese Physics C

Introduction

- Caitriana Nicholson, c.nicholson@ihep.ac.cn
- Editor at Chinese Physics C
- Previous experience (PhD, postdocs) in data management for high energy physics experiments (ATLAS, BESIII)

Today's lecture

- Why we write scientific papers
- Structure of a typical paper

- Next 2 lectures:
 - Common problems with academic writing
 - Submitting your paper to an international journal

Why do we write scientific papers?

- Let others know about our work
- Increase the body of scientific knowledge, benefit humanity
- Graduate!
- Get promotion!

Why do we write scientific papers?

- We see these aims in the very first scientific journal, Philosophical Transactions of the Royal Society, 1665
- Volume 1, Issue 1, page 1 – a letter from the Editor, Henry Oldenburg, to his authors and readers:

terns, that may animate, and
fal Assiftances.

*The Great God prosper You in the Noble
Engagement of Dispersing the true Lustre of his
Glorious Works, and the Happy Inventions of
obliging Men all over the World, to the General
Benefit of Mankind: So wishes with real
Affections,*

Your humble
HENR

Increase scientific
knowledge

The great God prosper you
in the noble engagement of
**dispersing the true lustre of
his glorious works**, and the
happy inventions of obliging
men all over the world, to the
general benefit of mankind”

Benefit
humanity

Let others know
about our work

Why do we write scientific papers?

- Let others know about our work
- Increase the body of scientific knowledge, benefit humanity
- Graduate!
- Get promotion!

Scientific papers are a **standard way** of **communicating** the results of scientific endeavour

Logical structure + clear writing = good communication



Structure of a Typical Paper

What are we communicating?



- To communicate successfully, a scientific paper should answer 4 main questions:
 - Why did I do this?
 - What did I do?
 - What results did I get?
 - What do the results mean?

The IMRAD format?

- Often used for biological / chemical sciences, and often taught in scientific writing classes

Introduction

Methods

Results

and

Discussion

- Doesn't usually fit HEP papers
- Main ideas are still important:
 - *Why did I do this?*
 - *What did I do?*
 - *What results did I get?*
 - *What do the results mean?*

A HEP (experiment) paper

- Introduction
- Detector & Data sample
- Analysis (models, simulation, event selection, backgrounds, uncertainties.....)
- Results (may be included in Analysis section(s))
- Discussion (may be included in Analysis section(s))
- Summary / conclusions

A HEP (experiment) paper

- Introduction

Why do this?

- Detector & Data sample

- Analysis (models, simulation, event selection, backgrounds, uncertainties.....)

- Results (may be included in Analysis section(s))

- Discussion (may be included in Analysis section(s))

- Summary / conclusions

What did we do?

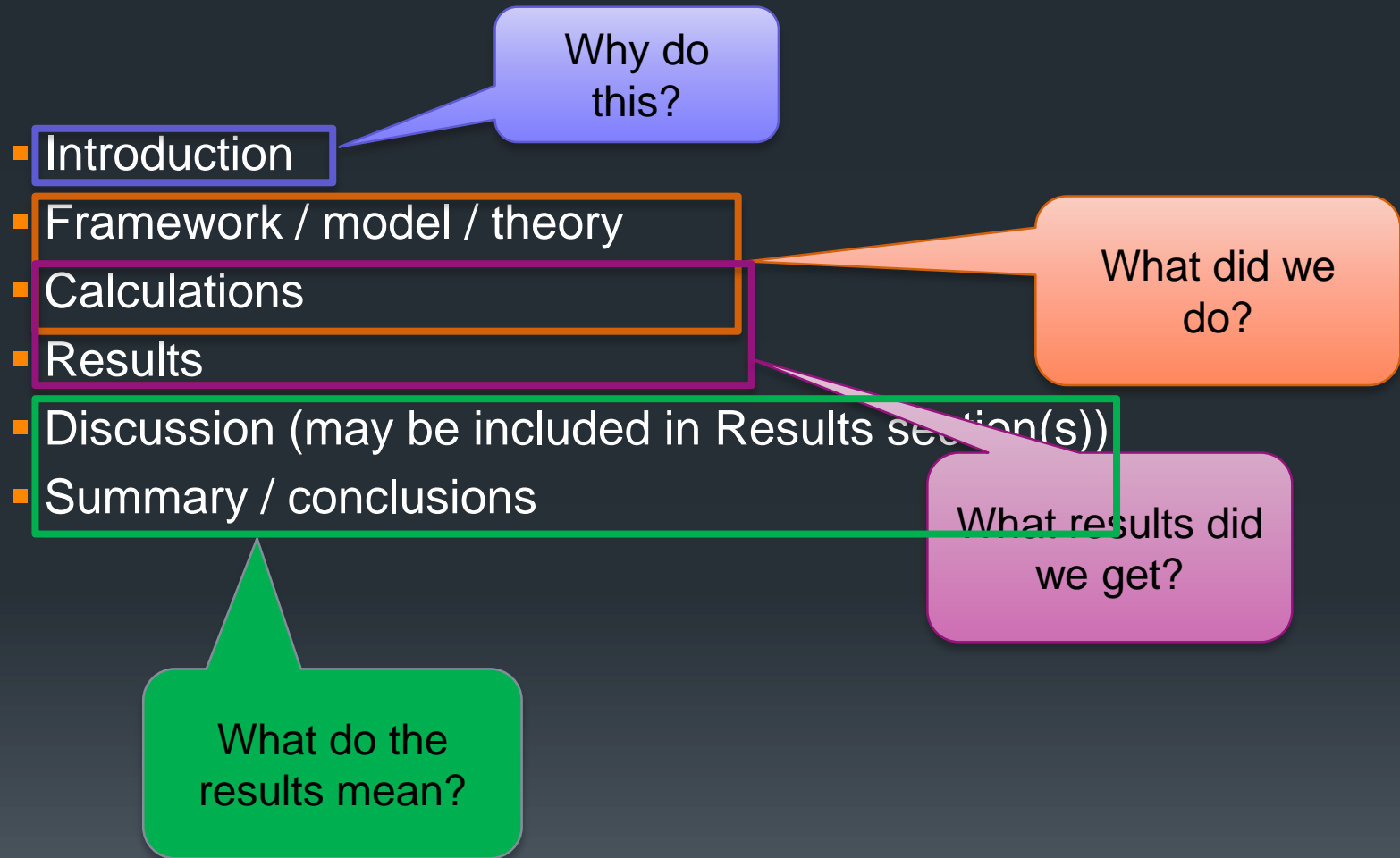
What results did we get?

What do the results mean?

A HEP (theory) paper

- Introduction
- Framework / model / theory
- Calculations
- Results
- Discussion (may be included in Results section(s))
- Summary / conclusions

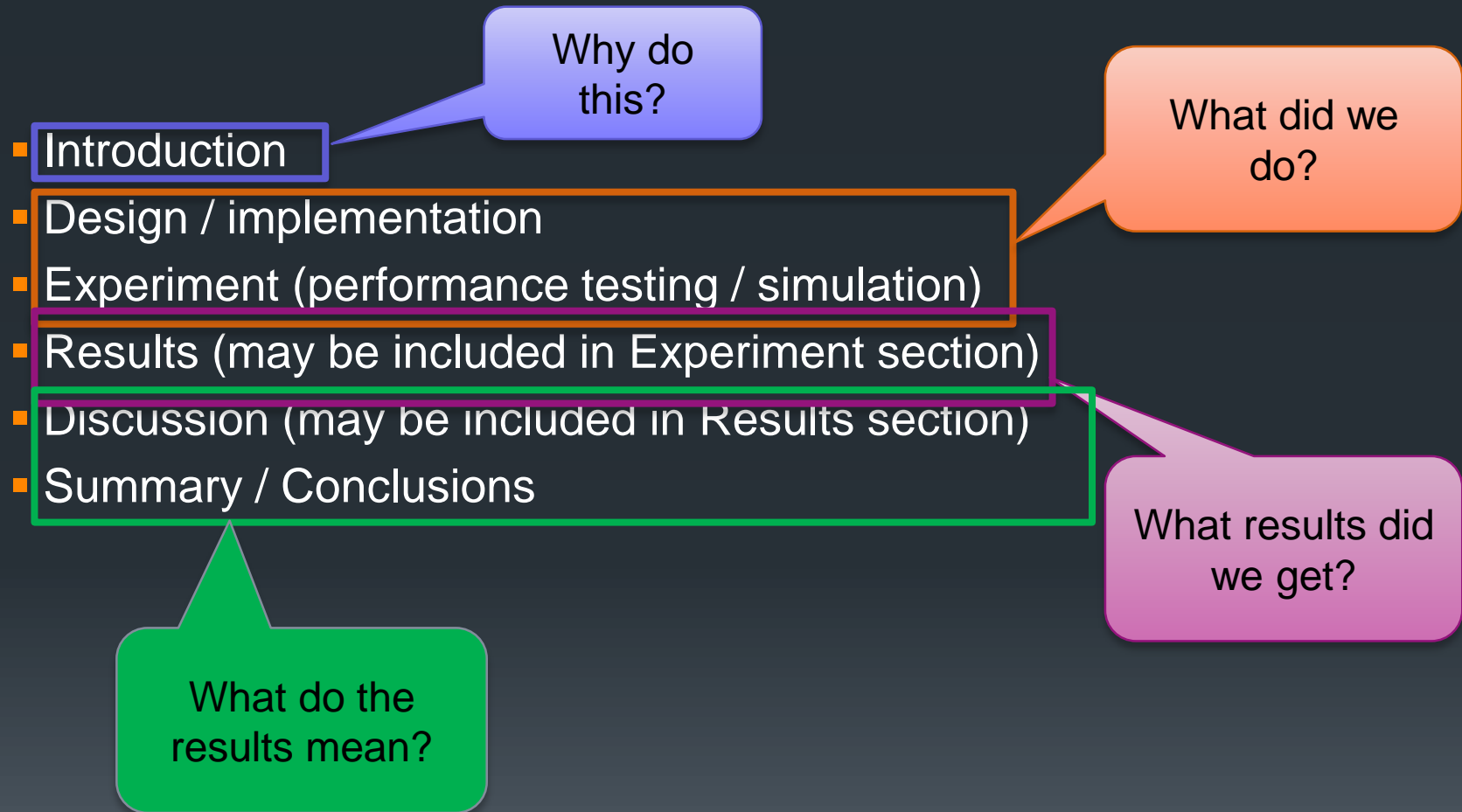
A HEP (theory) paper



A detector / accelerator / computing paper

- Introduction
- Design / implementation
- Experiment (performance testing / simulation)
- Results (may be included in Experiment section)
- Discussion (may be included in Results section)
- Summary / Conclusions

A detector / accelerator / computing paper



Standard structure???

- Different fields / subfields may have different 'standard' structures for a paper
- Follow the standard form for your field, if possible – but don't force your paper into an unsuitable structure
- Remember your aim: let others know about your work
- Communicate as clearly as possible:
 - *Why you did the work (why it's important)*
 - *What you did*
 - *What the results were*
 - *What the results mean*

Where do you start?

1. The data: prepare your Tables / Figures / other results
 - This is what you really want to show your readers, the heart of the paper
2. Methods, Results, Discussion
 - The main body of the paper
3. Conclusion
4. Introduction
5. Abstract
6. Title
7. Keywords
8. References
 - Write at the end, but choose at the start when doing literature review!
9. Acknowledgements, funding info etc

Tables and Figures

- A picture is worth a thousand words!
- Tables and figures (your data) are the heart of your paper
 - They might be the ONLY thing (other than title and abstract) that a reader (or editor!) looks at!
- Tables and figures should be standalone – a reader should understand them without having to refer back to the text
- Tables, figures and text should not repeat the same information
- Only use photographs if they add useful information which cannot be shown in a diagram
- **Re-using figures from previously published work may require copyright permission from the original publisher – even for your own paper**

Tables

Caption: clear and full explanation

TABLE III. Model-independent 95% confidence-level upper limits on the visible cross section for new physics in each of our searches.

Channel	Upper limit on visible cross section [fb]
DV + jet	0.14
DV + E_T^{miss}	0.15
DV + muon	0.15
DV + electron	0.15
e^+e^-	0.14
$\mu^+\mu^-$	0.14
$e^\pm\mu^\mp$	0.15

Correct units

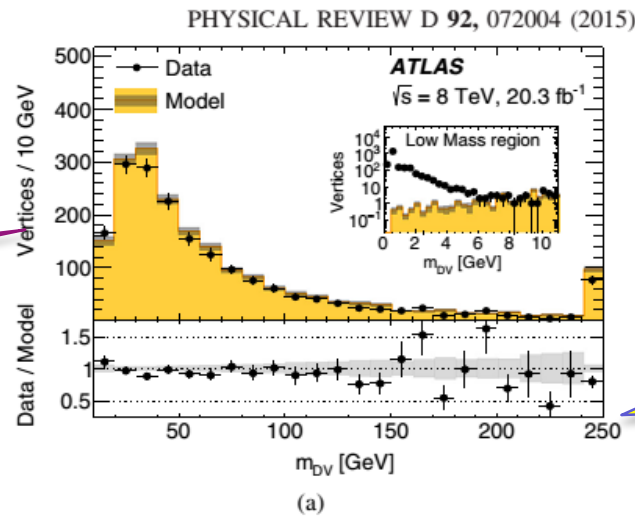
Neat alignment

Three horizontal lines; no lines in between rows, no vertical lines (unless necessary)

Appropriate number of significant figures

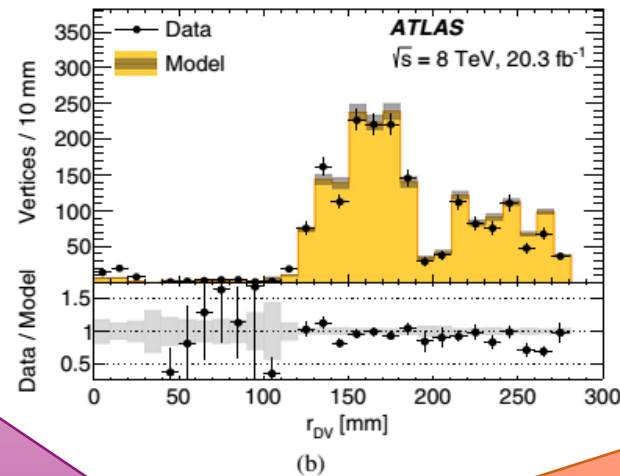
Figures

Clear axis labels with correct units



Suitable size of axis font

For colour figures, make sure you know the journal's policy on colour printing, and make the figures understandable even if printed black-and-white



Label different parts (a), (b) etc rather than top / bottom / left / right – position of figures may change during typesetting

Caption: clear and full explanation

FIG. 8 (color online). Distributions of the (a) vertex mass and (b) vertex position radius for vertices composed of two nonlepton tracks in the data sample (data points), and the predicted model distribution obtained from vertices formed by combining tracks from two different data events (shaded histograms). The ratio of the data to the model distributions is shown below each plot. The gray bands indicate the statistical uncertainties for the predicted distributions. The inset shows the mass distribution in the low-mass region, elsewhere $m_{DV} > 10$ GeV is required. In (a), the highest bin shows the histogram overflow.

From G. Aad et al (ATLAS Collaboration), PRD92,072004 (2015)

Method

- Method / what you did
 - Explain clearly and with enough detail for someone else in your field to be able to repeat what you did
 - Just give reference to well-known methods or systems (e.g. HEP-EX papers – brief detector description with reference to main detector paper)
 - Split into sub-sections for different parts of the experiment / analysis / calculation

Results

- Results / what you found
 - Give summary of **most important** results, referring to your figures / tables
 - Less important data can often be submitted as “Supporting Materials”
 - Describe trends and relationships, don’t just repeat numbers from the figures
 - Don’t refer to other work in this section – that goes in the Discussion section

Discussion

- Discussion / what the results mean
 - This is a really important section – lots of papers get rejected because of poor discussion (or no discussion..)
 - Explain how your results answer the question you were researching
 - Compare your results with other published work in your field
 - If your work disagrees with others, try to explain it – show the reader why you think you are right and the others wrong
 - Be specific, not vague
 - Avoid phrases like “significantly higher”, “relatively well” and so on – use quantitative phrases (“20% higher”, “within 3 sigma”, ...)

Conclusion

- Conclusion
 - Show how your work adds to overall knowledge of your field
 - Say how your results can be used or extended
 - Give suggestions for further work
 - DO NOT just repeat the results or copy the Abstract!

Introduction

- Introduction
 - Explain why you want to do this research
 - Main parts:
 - What we know already
 - What we don't know
 - The question you want to answer
 - How you plan to answer it
 - Do not give your results in this section!
 - Write as concisely as possible

1. Introduction

What we know

Searches for stops – the supersymmetric (SUSY) partners of top quarks – have received significant attention from both ATLAS [1–6] and CMS [7–12]. While limits obtained after Run 1 of the LHC at $\sqrt{s} = 8$ TeV can go, depending on the decay modes studied, up to 800 GeV, there are still parts of parameter space where relatively light stops are allowed, see e.g. the summary plots by ATLAS [13] and CMS [14].

The main motivation for light stops is the so-called natural supersymmetry [15] paradigm which demands that the particles must be close in mass to the ordinary top quark. Unfortunately however, this region of parameter space is particularly difficult to explore due to the background of top quark production. In particular if the stop quark decays via a top quark that is almost on-shell ($\tilde{t}_1 \rightarrow \tilde{\chi}_1^0 t^{(*)}$), no exclusion limit is currently present. Another difficult region of the parameters space can be identified at the border between three- and four-body decays with a (nearly) on-shell W boson ($\tilde{t}_1 \rightarrow \tilde{\chi}_1^0 W^{(*)} b$).

Several recent theoretical studies have attempted to fill these holes in the stop parameter space by using precise predictions and measurements of top quark cross section [16] (see however Ref. [17] for a discussion of possible problems with this approach), specialized mono-jet searches [18], recasting other

SUSY searches [19] or via angular correlations [20]. A complementary idea is that certain corners of the parameter space might be constrained by looking for signals of stoponium production [21].

An alternative approach presented here is based on the observation that light stops decaying into certain final states can contribute to the W^+W^- cross section measurements [22–26]. Until recently the ATLAS and CMS results were displaying a moderate excess over the standard model (SM) prediction [27–29] but this was determined to be the result of neglected higher order corrections [30–32]. In any case, the fact that the observed cross-section was greater than the predicted background meant that any derived constraints on stop production would have been weak. However, the recent CMS measurement [33] based on the full $\sqrt{s} = 8$ TeV dataset, using the next-to-next-to-leading-order (NNLO) cross section prediction, $\sigma^{\text{NNLO}}(pp \rightarrow W^+W^-) = 59.8_{-1.1}^{+1.3}$ pb [30], and event reweighting [32] turned out to be very well aligned with the SM: $\sigma^{\text{exp}} = 60.1 \pm 4.8$ pb. In this Letter, we recast the CMS analysis as a potential way to constrain the production of light stops.

We focus on three widely studied decay modes that are commonly present in SUSY models with light stops and improve the existing constraints. Assuming that only the light stop and the lightest supersymmetric particle (LSP, in our case the lightest neutralino, $\tilde{\chi}_1^0$) have masses of order of the electroweak symmetry breaking (EWSB) scale we have:

$$\tilde{t}_1 \rightarrow \tilde{\chi}_1^0 t, \quad (1)$$

the question we want to answer, and how we plan to answer it

What we don't know

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SCOPAP³.

Abstract

- What is the abstract for?



Abstract



- What is the abstract for?
 - The ‘movie poster’ for your paper
 - Editors and readers may just read the title and abstract before deciding whether to read the whole paper
- Must give a clear, short description of:
 - What you did
 - What the main results are
- Give a sentence to summarise each section
- Avoid jargon and references
- Don't cut-and-paste sentences from the body of the paper!

Abstract

Many extensions of the Standard Model posit the existence of heavy particles with long lifetimes. This article presents the results of a search for events containing at least one long-lived particle that decays at a significant distance from its production point into two leptons or into five or more charged particles. This analysis uses a data sample of proton-proton collisions at $\sqrt{s} = 8$ TeV corresponding to an integrated luminosity of 20.3 fb^{-1} collected in 2012 by the ATLAS detector operating at the Large Hadron Collider. No events are observed in any of the signal regions, and limits are set on model parameters within supersymmetric scenarios involving R -parity violation, split supersymmetry, and gauge mediation. In some of the search channels, the trigger and search strategy are based only on the decay products of individual long-lived particles, irrespective of the rest of the event. In these cases, the provided limits can easily be reinterpreted in different scenarios.

From G. Aad et al (ATLAS
Collaboration),
PRD92,072004 (2015)

Abstract

Why do this?

What did we do?

Many extensions of the Standard Model posit the existence of heavy particles with long lifetimes. This article presents the results of a search for events containing at least one long-lived particle that decays at a significant distance from its production point into two leptons or into five or more charged particles. This analysis uses a data sample of proton-proton collisions at $\sqrt{s} = 8$ TeV corresponding to an integrated luminosity of 20.3 fb^{-1} collected in 2012 by the ATLAS detector operating at the Large Hadron Collider. No events are observed in any of the signal regions, and limits are set on model parameters within supersymmetric scenarios involving R -parity violation, split supersymmetry, and gauge mediation. In some of the search channels, the trigger and search strategy are based only on the decay products of individual long-lived particles, irrespective of the rest of the event. In these cases, the provided limits can easily be reinterpreted in different scenarios.

What do the results mean?

What results did we get?

From G. Aad et al (ATLAS Collaboration),
PRD92,072004 (2015)

Title & keywords



- Keep the title as **short** and **precise** as possible
- The title should give a clear idea of what the paper is about
- Avoid making the title a question or a pun – it should be easily searchable

- Keywords – check the journal guidelines for authors
- Used for indexing and searches
- Avoid words already in the title

Final analysis of KEDR data on J/ψ and $\psi(2S)$ masses

Open Access

Pages 50-56

V.V. Anashin, V.M. Aulchenko, E.M. Baldin, A.K. Barladyan, A.Yu. Barnyakov, M.Yu. Barnyakov, S.E. Baru, I.Yu. Basok, A.M. Batrakov, A.E. Blinov, V.E. Blinov, A.V. Bobrov, V.S. Bobrovnikov, A.V. Bogomyagkov, A.E. Bondar, A.A. Borodenko, A.R. Buzykaev, S.I. Eidelman, D.N. Grigoriev, Yu.M. Glukhovchenko, S.E. Kamaev, *et al.*

Abstract | PDF (569 K)

Measurement of charged jet production cross sections and nuclear modification in p-Pb collisions at $\sqrt{s_{NN}} = 5.02$ TeV

Open Access

Pages 68-81

ALICE Collaboration

Abstract | PDF (978 K)

Single neutral pion production by charged-current $(E_\nu) = 3.6$ GeV

Open Access

Pages 130-136

T. Le, J.L. Palomino, L. Aliaga, O. Altinok, A. Bercellie, A. Martinez Caicedo, M.F. Carneiro, M.E. Christy, J. Chvojil, Eberty, J. Felix, L. Fields, R. Fine, *et al.*

Abstract | PDF (730 K) | Supplementary content

Search for chameleons with CAST

Open Access

Pages 172-180

V. Anastassopoulos, M. Arik, S. Aune, K. Barth, A. Belov, H. Bräuninger, G. Cantatore, J.M. Carmona, S.A. Cetin, F. Christensen, J.I. Collar, T. Dafni, M. Davenport, K. Desch, A. Demenev, C. Eleftheriadis, G. Fanourakis, E. Ferrer-Ribas, P. Friedrich, J. Galán, J.A. García, *et al.*

Abstract | PDF (685 K)

Measurement of the Z boson differential cross section in transverse momentum and rapidity in proton-proton collisions at 8 TeV













Open Access

Pages 187-209

CMS Collaboration

Abstract | PDF (1224 K)



- [Dual lattice representations for \$O\(N\)\$ and \$CP\(N - 1\)\$ models with a chemical potential](#) Open Access 
Pages 495-501
Falk Bruckmann, Christof Gattringer, Thomas Kloiber, Tin Sulejmanpasic
[▶ Abstract](#) |  [PDF \(329 K\)](#)
- [Anomalous properties of spin-extended chiral fermions](#) Open Access 
Pages 502-506
M. Elbistan, P.A. Horváthy
[▶ Abstract](#) |  [PDF \(335 K\)](#)
- [A note on Boltzmann brains](#) Open Access 
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Yasunori Nomura
[▶ Abstract](#) |  [PDF \(380 K\)](#)
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[▶ Abstract](#) |  [PDF \(200 K\)](#)
- [Renormalised fermion vacuum expectation values on anti-de Sitter space–time](#) Open Access 
Pages 597-602
Victor E. Ambrus, Elizabeth Winstanley
[▶ Abstract](#) |  [PDF \(295 K\)](#)

Vague – ‘a note’ could say anything

References

- References:
 - Check the format for the journal you're submitting to
 - Aim for **20-50** references
 - Make sure you include the most **up-to-date** references for your topic
 - Don't just cite your own papers

Acknowledgements

- Thank people who have helped in some way, but who have not contributed enough to be listed as authors
- Funding is usually also acknowledged here

Quiz: how many problems can you spot?

- Look at the following 3 slides and note:
 - Any problems you can see
 - Any ways you can think of to improve these papers
- You will have 2 minutes per slide

Abstract: The spin is an important property of a particle. Although it is unlikely, there is still a possibility that two particles with different spins share similar masses. In this paper, we propose a method to probe this kind of mass degeneracy of particles with different spins. We use the cascade decay $B^+ \rightarrow X(3872)K^+$, $X(3872) \rightarrow D^+D^-$ to illustrate our method. It can be seen that the possible mass degeneracy of $X(3872)$ can lead to interesting behavior in the corresponding cascade decay.

Key words: $X(3872)$, mass degeneracy, B meson

PACS: 13.25.Gv, 14.40.-n, 14.40.Rt

DOI:

1 Introduction

It is always important to determine the spin of a new particle once it is discovered. However, the statistics of events corresponding to the new particle are usually low. As a result, sometimes we find that there are several possibilities for the spin of the new particle. Consequently, it is possible that several particles with different spins share similar masses. In this paper, we propose a method to confirm or exclude this possibility.

We will use the cascade decay $B^\pm \rightarrow X(3872)K^\pm$, $X(3872) \rightarrow D^+D^-$ as an example to explain our method. $X(3872)$ was first discovered by the Belle Collaboration in 2003 and was the first exotic hadron to be discovered [1]. At first, the analysis of the $X(3872)$ angular distribution

2 Formalism

To probe the degeneracy of $X(3872)$, we assume that there are two particles with spin 1 and 2, respectively, and with masses about 3872 MeV. We will denote these two particles as X_1 and X_2 respectively.

When the invariant mass of the D^+D^- pair lies around 3872 MeV, the decay amplitude \mathcal{M} for the cascade decay can be expressed as [5]

$$\mathcal{M}(s_{12}, s_{13}) = a_1 P_1(g_{s_{D\bar{D}}}(s_{DK})) + a_2 P_2(g_{s_{D\bar{D}}}(s_{DK})), \quad (1)$$

where P_l ($l = 1, 2$) is the $(l+1)^{\text{th}}$ Legendre polynomial, $a_l P_l$ represents the decay amplitude with X_l being the intermediate resonance, and $s_{D\bar{D}}$ and s_{DK} are the invariant mass squared of the D^+D^- pair and the D^+ and K^+ respectively ($D(\bar{D})$ in the subscript represents $D^+(D^-)$).

$$\frac{\bar{\kappa}^2}{l}(\rho + p) = \frac{4x^3}{m^2(1+x)^2(q+x)^2} \left[-4q\xi\beta + q(q+1)(\xi^2 - 1) \right. \\ \left. + x(8(q-1)\xi\beta + (1+q)^2(\xi^2 - 1)) \right. \\ \left. + x^2(4\xi\beta + (1+q)(\xi^2 - 1)) \right] \quad (26)$$

In the above expression, we have used the following re-definitions.

$$x = \frac{m}{2r} \quad ; \quad C_1 = \alpha m \quad ; \quad \beta = \frac{\alpha}{\kappa - \lambda} \quad (27)$$

The wormhole throat is at $r = \frac{m}{2}$ (or $r' = 2m$). Hence, the domain of x is from $x = 0$ to $x = 1$. One can check that the above stress energy is traceless.

The radion field as a function of x is given in terms of ξ where ξ is written as:

$$\xi(x) = \sqrt{1 + \Phi} = \frac{\alpha}{\lambda} \ln \frac{q+x}{1+x} + C_4 \quad (28)$$

We have $\beta = \frac{\alpha}{\kappa - \lambda}$. Defining $\frac{\kappa}{\lambda} = \nu$, we get $q = \frac{\nu+1}{\nu-1}$. Also $\beta = \frac{\alpha}{\lambda} \frac{1}{\nu-1}$. Since $\nu = \frac{q+1}{q-1}$, we get $\frac{\alpha}{\lambda} = \frac{2\beta}{q-1}$. Hence all the inequalities as well as the radion field are now defined in terms of the parameters q , β and C_4 .

We must now explicitly check the Weak Energy Condition inequalities $\rho \geq 0$, $\rho + \tau \geq 0$ and $\rho + p \geq 0$. To this end, we plot the graphs of these quantities for some sample values of the various parameters. A general proof for all parameters is not easy. We first note that ρ is always greater than zero, irrespective of our choice of β , q or C_4 as long as $\beta > 0$, $q > 1$ and $C_4 > 0$. Fig. 1 shows the plot for ρ as a function of x . For the other two inequalities, let us look at the values of the term inside the square brackets in (25) and (26), for $x = 0$. Note that the values are exactly opposite to each other. The relevant term is

$$-4q\beta\xi(x=0) + q(q+1)(\xi^2(x=0) - 1) \quad (29)$$

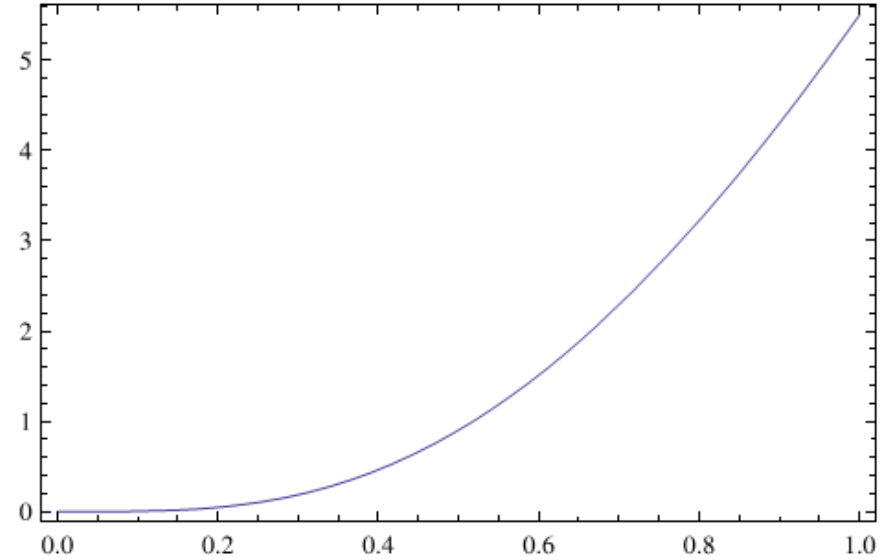


Fig. 1. ρ vs. x .

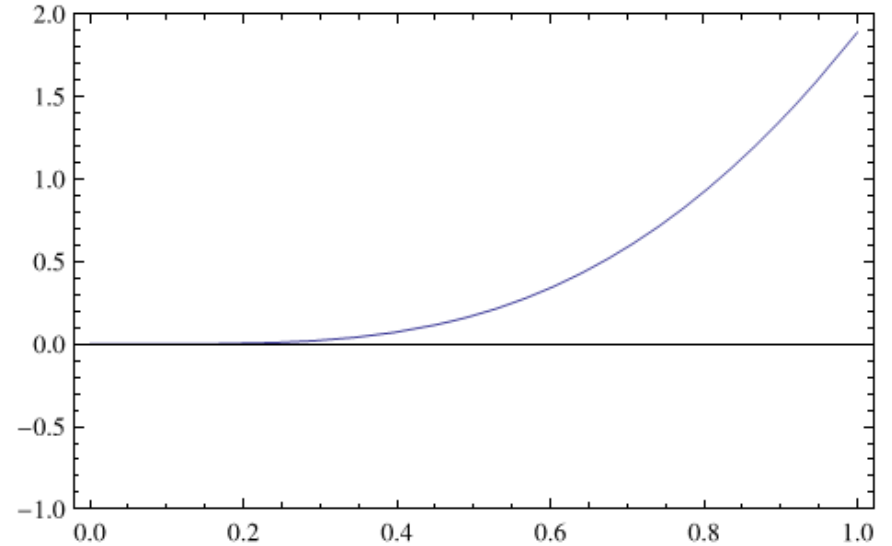


Fig. 2. $\rho + \tau$ vs. x .

discharge time	<200 ns
output voltage noise	<4.6 mV (rms)
output offset voltage	< ± 4.1 mV
linearity error	0.051% to 1.280%
time resolution	0.066% to 0.871%
absolute resolution	261 ps to 656 ps

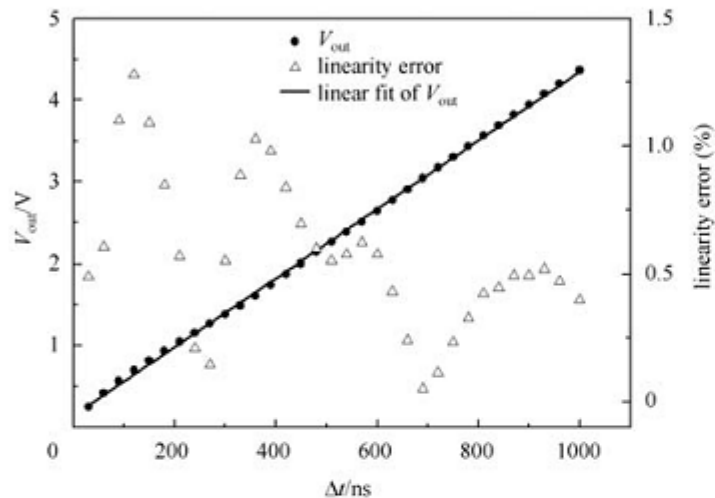


Fig. 10. Transfer curve and linearity errors of TAC.

Parameters of the TAC and the QAC are shown in Tables 1 and 2; each test point includes more than 10 million events. The transfer curve and linearity errors of TAC are shown in Fig. 10. The longer the time interval under test, the better the resolution. The transfer curve and linearity errors of QAC are shown in Fig. 11. The higher the input charge, the better the resolution.

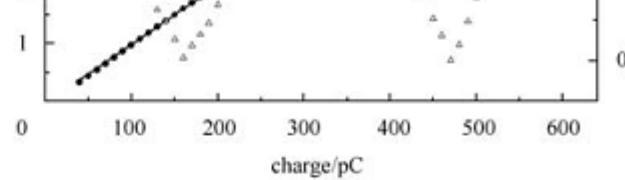


Fig. 11. Transfer curve and linearity errors of QAC.

5 Summary

This NIM module and a normal DAQ system are used to constitute a TDC and QDC system, and a comparison test has been implemented. When the Phillips CAMAC Model 7120 is chosen as the signal source, the performance of this system is superior to some commercial TDC and QDC modules; the linearity error and resolution of this NIM module are little better than the commercial CAMAC module. The characteristics of the TAC and QAC circuits are a high processing speed, simple circuit structure, high precision and low power dissipation, and also a low manufacture cost. In particular, this NIM module can read out the time interval and charge information simultaneously with the same signal. The resolution and linearity error are a little worse at the very low measurement range, which needs to be improved. This module can be used widely to construct a front-end read-out electronics system for large array detectors.

References

- 1 YU Yu-Hong, XU Hua-Gen, XU Hu-Shan et al. *Chin. Phys. C*, 2009, **33**(9): 781–784
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Probing the mass degeneracy of particles with different spins*

Title is vague

Abstract: The spin is an important property of a particle. Although it is unlikely, there is still a possibility that two particles with different spins share similar masses. In this paper, we propose a method to probe this kind of mass degeneracy of particles with different spins. We use the cascade decay $B^+ \rightarrow X(3872)K^+$, $X(3872) \rightarrow D^+D^-$ to illustrate our method. It can be seen that the possible mass degeneracy of $X(3872)$ can lead to interesting behavior in the corresponding cascade decay.

Key words: $X(3872)$, mass degeneracy, B meson

PACS: 13.25.Gv, 14.40.-n, 14.40.Rt

DOI:

Abstract says nothing useful about the method or the results

1 Introduction

Does not mention previous methods / why this new method is needed

It is always important to determine the spin of a new particle once it is discovered. However, the statistics of events corresponding to the new particle are usually low. As a result, sometimes we find that there are several possibilities for the spin of the new particle. Consequently, it is possible that several particles with different spins share similar masses. In this paper, we propose a method to confirm or exclude this possibility.

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$$\mathcal{M}(s_{12}, s_{13}) = a_1 P_1(g_{s_{D\bar{D}}}(s_{DK})) + a_2 P_2(g_{s_{D\bar{D}}}(s_{DK})), \quad (1)$$

where P_l ($l = 1, 2$) is the $(l+1)^{\text{th}}$ Legendre polynomial, $a_l P_l$ represents the decay amplitude with X_l being the intermediate resonance, and $s_{D\bar{D}}$ and s_{DK} are the invariant mass squared of the D^+D^- pair and the D^+ and K^+ respectively ($D(\bar{D})$ in the subscript represents $D^+(D^-)$).

$$\frac{\bar{\kappa}^2}{l}(\rho + p) = \frac{4x^3}{m^2(1+x)^2(q+x)^2} \left[-4q\xi\beta + q(q+1)(\xi^2 - 1) \right. \\ \left. + x(8(q-1)\xi\beta + (1+q)^2(\xi^2 - 1)) \right. \\ \left. + x^2(4\xi\beta + (1+q)(\xi^2 - 1)) \right] \quad (26)$$

In the above expression, we have used the following re-definitions.

$$x = \frac{m}{2r} ; \quad C_1 = \alpha m ; \quad \beta = \frac{\alpha}{\kappa - \lambda} \quad (27)$$

The wormhole throat is at $r = \frac{m}{2}$ (or $r' = 2m$). Hence, the domain of x is from $x = 0$ to $x = 1$. One can check that the above stress energy is traceless.

The radion field as a function of x is given in terms of ξ where ξ is written as:

$$\xi(x) = \sqrt{1 + \Phi} = \frac{\alpha}{\lambda} \ln \frac{q+x}{1+x} + C_4 \quad (28)$$

We have $\beta = \frac{\alpha}{\kappa - \lambda}$. Defining $\frac{\kappa}{\lambda} = \nu$, we get $q = \frac{\nu+1}{\nu-1}$. Also $\beta = \frac{\alpha}{\lambda} \frac{1}{\nu-1}$. Since $\nu = \frac{q+1}{q-1}$, we get $\frac{\alpha}{\lambda} = \frac{2\beta}{q-1}$. Hence all the inequalities as well as the radion field are now defined in terms of the parameters q , β and C_4 .

We must now explicitly check the Weak Energy Condition inequalities $\rho \geq 0$, $\rho + \tau \geq 0$ and $\rho + p \geq 0$. To this end, we plot the graphs of these quantities for some sample values of the various parameters. A general proof for all parameters is not easy. We first note that ρ is always greater than zero, irrespective of our choice of β , q or C_4 as long as $\beta > 0$, $q > 1$ and $C_4 > 0$. Fig. 1 shows the plot for ρ as a function of x . For the other two inequalities, let us look at the values of the term inside the square brackets in (25) and (26), for $x = 0$. Note that the values are exactly opposite to each other. The relevant term is

$$-4q\beta\xi(x=0) + q(q+1)(\xi^2(x=0) - 1) \quad (29)$$

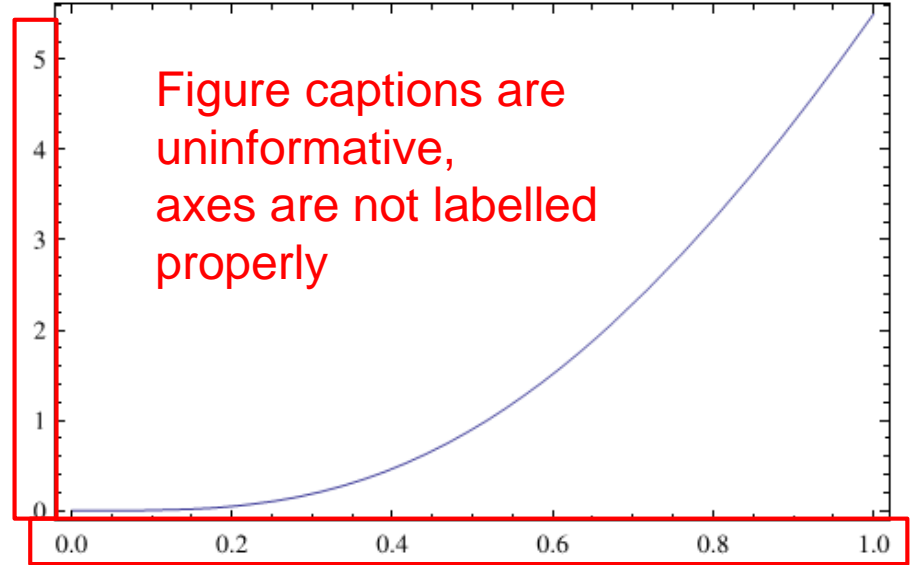


Figure captions are uninformative, axes are not labelled properly

Fig. 1. ρ vs. x .

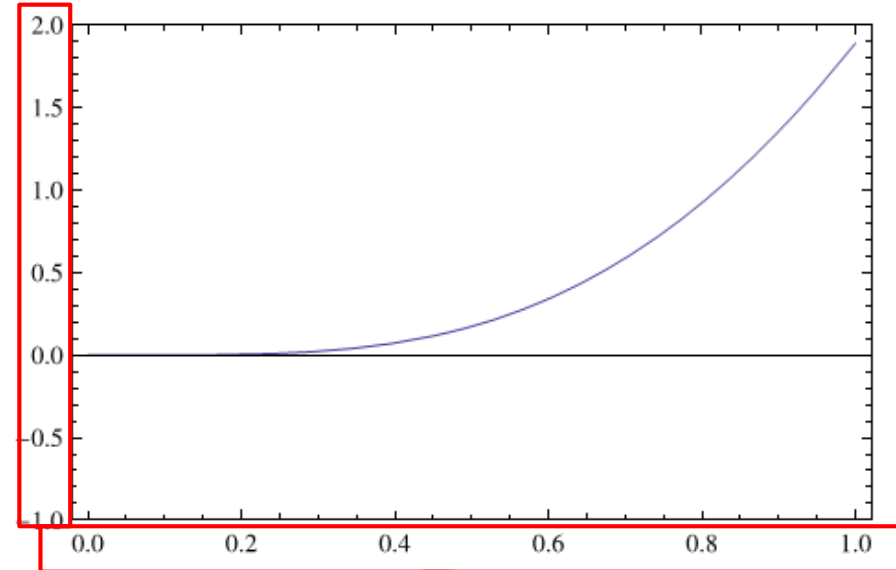


Fig. 2. $\rho + \tau$ vs. x .

discharge time	<200 ns
output voltage noise	<4.6 mV (rms)
output offset voltage	< ± 4.1 mV
linearity error	0.051% to 1.280%
time resolution	0.066% to 0.871%
absolute resolution	261 ps to 656 ps

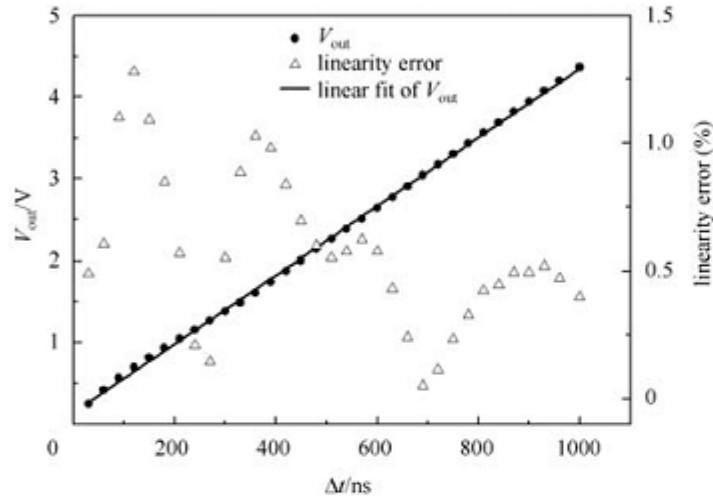


Fig. 10. Transfer curve and linearity errors of TAC.

Parameters of the TAC and the QAC are shown in Tables 1 and 2; each test point includes more than 10 million events. The transfer curve and linearity errors of TAC are shown in Fig. 10. The longer the time interval under test, the better the resolution. The transfer curve and linearity errors of QAC are shown in Fig. 11. The higher the input charge, the better the resolution.

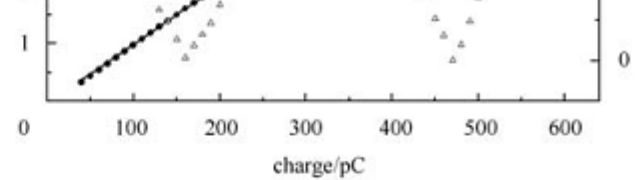


Fig. 11. Transfer curve and linearity errors of QAC.

5 Summary

This NIM module and a normal DAQ system are used to constitute a TDC and QDC system, and a comparison test has been implemented. When the Phillips CAMAC Model 7120 is chosen as the signal source, the performance of this system is superior to some commercial TDC and QDC modules; the linearity error and resolution of this NIM module are little better than the commercial CAMAC module. The characteristics of the TAC and QAC circuits are a high processing speed, simple circuit structure, high precision and low power dissipation, and also a low manufacture cost. In particular, this NIM module can read out the time interval and charge information simultaneously with the same signal. The resolution and linearity error are a little worse at the very low measurement range, which needs to be improved. This module can be used widely to construct a front-end read-out electronics system for large array detectors.

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Summary

- Remember your goal: clear communication
- Make sure your paper says:
 - Why you did this work
 - What you did
 - What the results were
 - What the results mean
- Start from the data
- Title, abstract and figures – the first things (maybe the only things) a reader will look at

Useful resources

- Elsevier.com – How to Prepare a Manuscript for International Journals
 - <https://www.elsevier.com/connect/six-things-to-do-before-writing-your-manuscript>
 - <https://www.elsevier.com/connect/11-steps-to-structuring-a-science-paper-editors-will-take-seriously>
 - <https://www.elsevier.com/connect/writing-a-science-paper-some-dos-and-donts>
- Duke University Graduate School Scientific Writing Resource
 - <https://cgi.duke.edu/web/sciwriting/index.php?action=lesson3>
- *Clinical Chemistry* Guide to Scientific Writing (has Chinese translations)
 - <https://www.aacc.org/publications/clinical-chemistry/clinical-chemistry%C2%A0guide-to-scientific-writing>

Useful resources

- Editage Insights <http://www.editage.com/insights/>
 - Editage provides English editing services (for a fee), but also has this useful website with tips for good writing (free)
- *Nature* English Communication for Scientists, free online course
 - <http://www.nature.com/scitable/ebooks/english-communication-for-scientists-14053993/writing-scientific-papers-14239285>
- Hemingway app – online tool to help make your writing clearer
 - <http://www.hemingwayapp.com/>

Acknowledgements

- I have referred to the following resources in preparing today's material:
 - Elsevier.com – How to Prepare a Manuscript for International Journals
 - <https://www.elsevier.com/connect/11-steps-to-structuring-a-science-paper-editors-will-take-seriously>
 - Duke University Graduate School Scientific Writing Resource
 - <https://cgi.duke.edu/web/sciwriting/index.php?action=lesson3>
 - Stanford University online course “Writing in the Sciences”, Kristin Sainani
 - <http://online.stanford.edu/course/writing-in-the-sciences>