The design of a Master Thesis

Andrea Donini
(curso organizado y supervisado con Pilar Hernández)

Motivation

Scientific writing is not taught at school, nor during the undergraduate learning

WE, professional scientists, LEARN how to write by TRIALS AND ERRORS, after many years of scientific papers publication and refereeing

Many of us NEVER LEARN! You can be a very good scientist and a poor writer….

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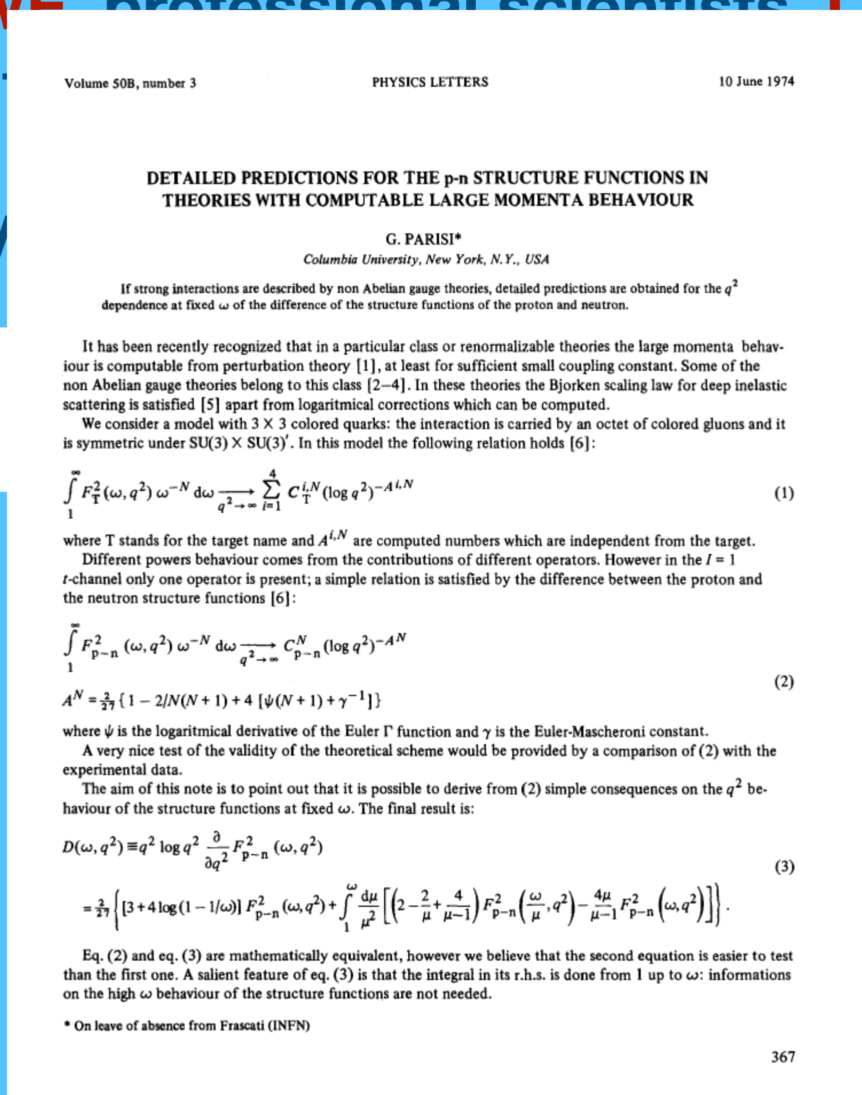

Volume 50B, number 3 PHYSICS LETTERS 10 June 1974

DETAILED PREDICTIONS FOR THE p-n STRUCTURE FUNCTIONS IN THEORIES WITH COMPUTABLE LARGE MOMENTA BEHAVIOUR

G. PARISI*
Columbia University, New York, N.Y., USA

If strong interactions are described by non Abelian gauge theories, detailed predictions are obtained for the q^2 dependence at fixed ω of the difference of the structure functions of the proton and neutron.

It has been recently recognized that in a particular class or renormalizable theories the large momenta behaviour is computable from perturbation theory [1], at least for sufficient small coupling constant. Some of the non Abelian gauge theories belong to this class [2–4]. In these theories the Bjorken scaling law for deep inelastic scattering is satisfied [5] apart from logaritmical corrections which can be computed.

We consider a model with 3 × 3 colored quarks: the interaction is carried by an octet of colored gluons and it is symmetric under SU(3) × SU(3)′. In this model the following relation holds [6]:

$$\int_1^\infty F_T^2(\omega, q^2)\, \omega^{-N}\, d\omega \xrightarrow[q^2\to\infty]{} \sum_{i=1}^{4} C_T^{i,N} (\log q^2)^{-A^{i,N}} \tag{1}$$

where T stands for the target name and $A^{i,N}$ are computed numbers which are independent from the target.

Different powers behaviour comes from the contributions of different operators. However in the $I = 1$ t-channel only one operator is present; a simple relation is satisfied by the difference between the proton and the neutron structure functions [6]:

$$\int_1^\infty F_{p-n}^2 (\omega, q^2)\, \omega^{-N}\, d\omega \xrightarrow[q^2\to\infty]{} C_{p-n}^N (\log q^2)^{-A^N}$$
$$A^N = \tfrac{2}{27}\{1 - 2/N(N+1) + 4\,[\psi(N+1) + \gamma^{-1}]\} \tag{2}$$

where ψ is the logaritmical derivative of the Euler Γ function and γ is the Euler-Mascheroni constant.

A very nice test of the validity of the theoretical scheme would be provided by a comparison of (2) with the experimental data.

The aim of this note is to point out that it is possible to derive from (2) simple consequences on the q^2 behaviour of the structure functions at fixed ω. The final result is:

$$D(\omega, q^2) \equiv q^2 \log q^2 \frac{\partial}{\partial q^2} F_{p-n}^2 (\omega, q^2)$$
$$= \tfrac{2}{27}\left\{[3 + 4\log(1 - 1/\omega)]\, F_{p-n}^2(\omega, q^2) + \int_1^\omega \frac{d\mu}{\mu^2}\left[\left(2 - \frac{2}{\mu} + \frac{4}{\mu-1}\right) F_{p-n}^2\left(\frac{\omega}{\mu}, q^2\right) - \frac{4\mu}{\mu-1} F_{p-n}^2\left(\omega, q^2\right)\right]\right\}. \tag{3}$$

Eq. (2) and eq. (3) are mathematically equivalent, however we believe that the second equation is easier to test than the first one. A salient feature of eq. (3) is that the integral in its r.h.s. is done from 1 up to ω: informations on the high ω behaviour of the structure functions are not needed.

* On leave of absence from Frascati (INFN)

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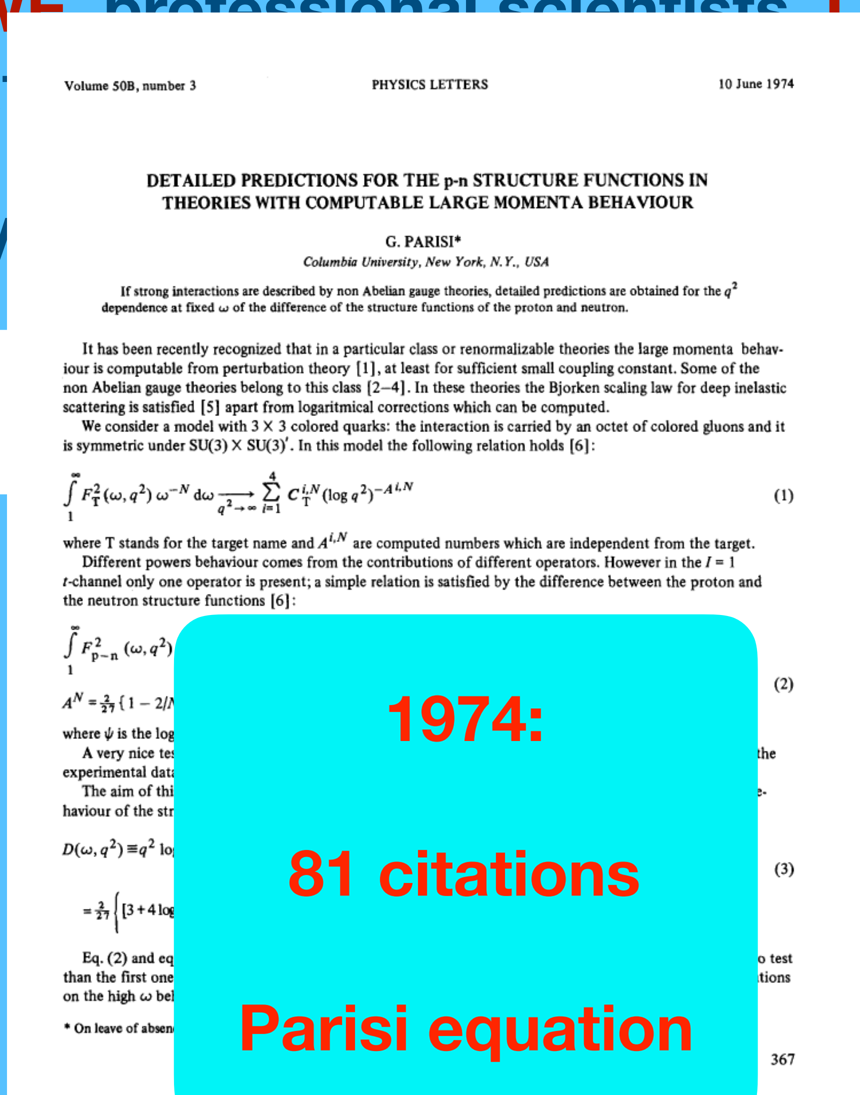

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where T stands for the target name and $A^{i,N}$ are computed numbers which are independent from the target.

Different powers behaviour comes from the contributions of different operators. However in the $I = 1$ t-channel only one operator is present; a simple relation is satisfied by the difference between the proton and the neutron structure functions [6]:

$$\int_1^\infty F_{p-n}^2(\omega, q^2) \ldots \quad (2)$$

$A^N = \frac{2}{27}\{1 - 2/N \ldots$

$D(\omega, q^2) \equiv q^2 \log \ldots \quad (3)$

367

1974:

81 citations

Parisi equation

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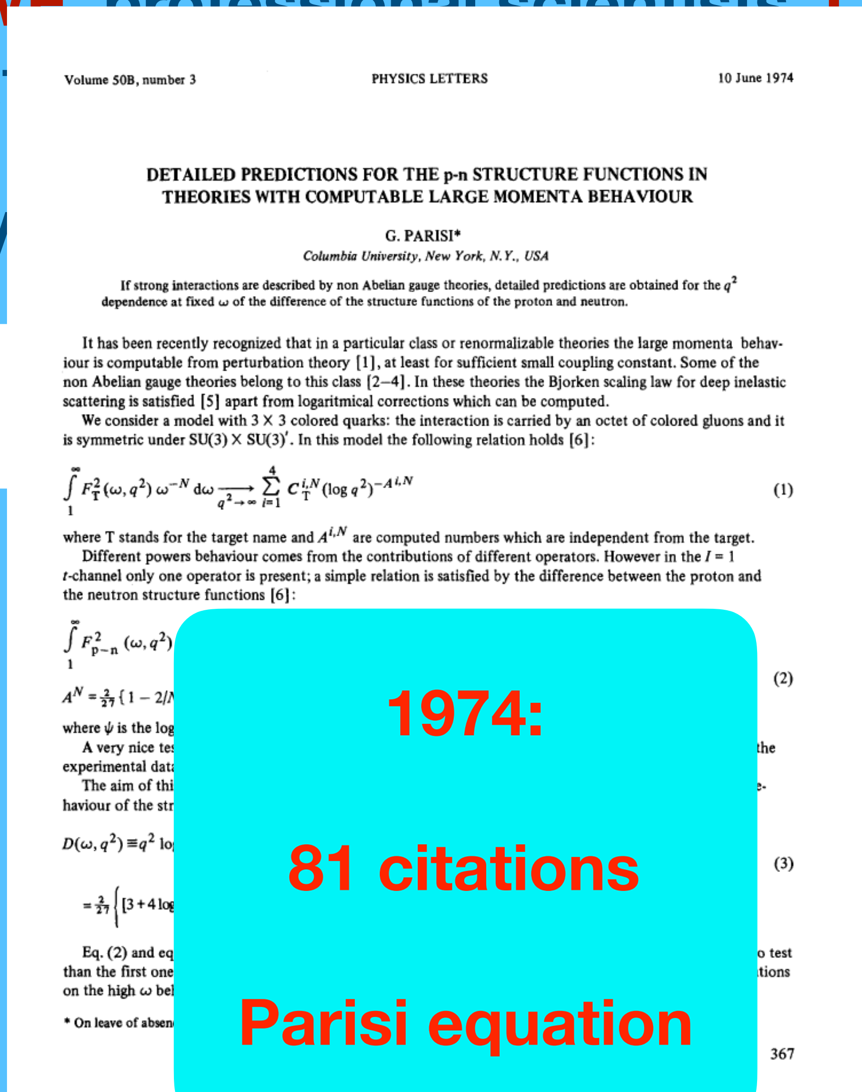

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A very nice tes[...] the experimental dat[...]

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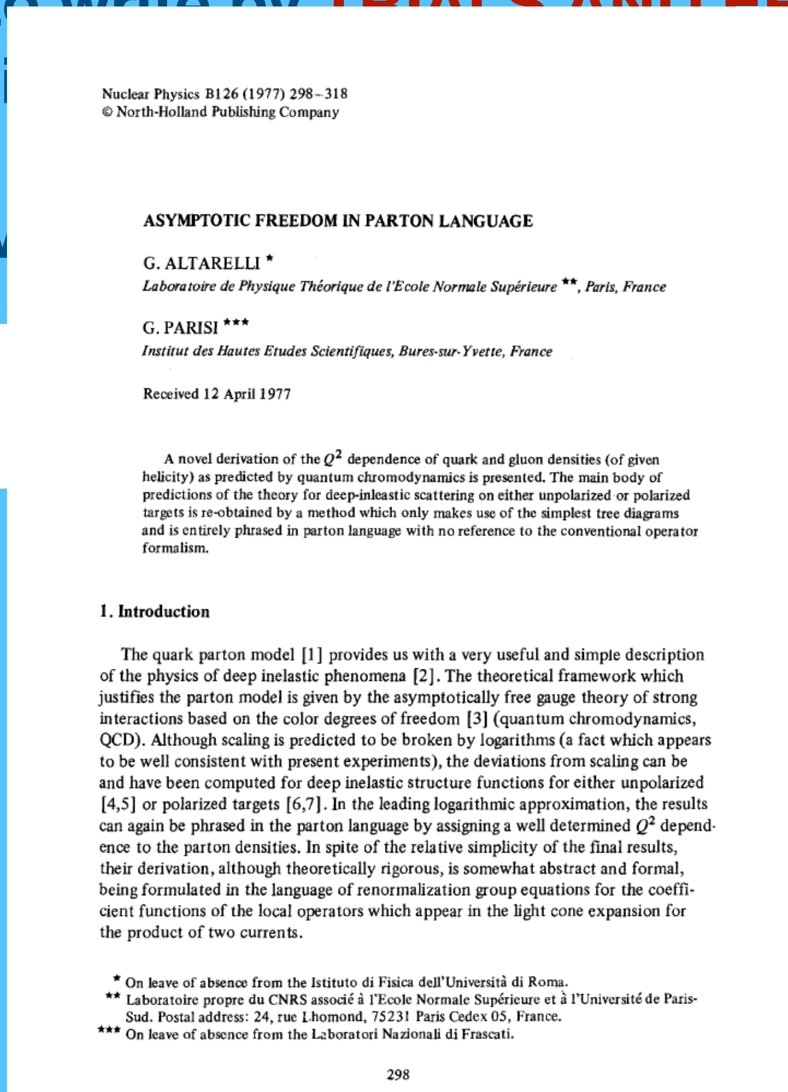

Nuclear Physics B126 (1977) 298–318
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ASYMPTOTIC FREEDOM IN PARTON LANGUAGE

G. ALTARELLI *
Laboratoire de Physique Théorique de l'Ecole Normale Supérieure **, *Paris, France*

G. PARISI ***
Institut des Hautes Etudes Scientifiques, Bures-sur-Yvette, France

Received 12 April 1977

A novel derivation of the Q^2 dependence of quark and gluon densities (of given helicity) as predicted by quantum chromodynamics is presented. The main body of predictions of the theory for deep-inleastic scattering on either unpolarized or polarized targets is re-obtained by a method which only makes use of the simplest tree diagrams and is entirely phrased in parton language with no reference to the conventional operator formalism.

1. Introduction

The quark parton model [1] provides us with a very useful and simple description of the physics of deep inelastic phenomena [2]. The theoretical framework which justifies the parton model is given by the asymptotically free gauge theory of strong interactions based on the color degrees of freedom [3] (quantum chromodynamics, QCD). Although scaling is predicted to be broken by logarithms (a fact which appears to be well consistent with present experiments), the deviations from scaling can be and have been computed for deep inelastic structure functions for either unpolarized [4,5] or polarized targets [6,7]. In the leading logarithmic approximation, the results can again be phrased in the parton language by assigning a well determined Q^2 dependence to the parton densities. In spite of the relative simplicity of the final results, their derivation, although theoretically rigorous, is somewhat abstract and formal, being formulated in the language of renormalization group equations for the coefficient functions of the local operators which appear in the light cone expansion for the product of two currents.

* On leave of absence from the Istituto di Fisica dell'Università di Roma.
** Laboratoire propre du CNRS associé à l'Ecole Normale Supérieure et à l'Université de Paris-Sud. Postal address: 24, rue Lhomond, 75231 Paris Cedex 05, France.
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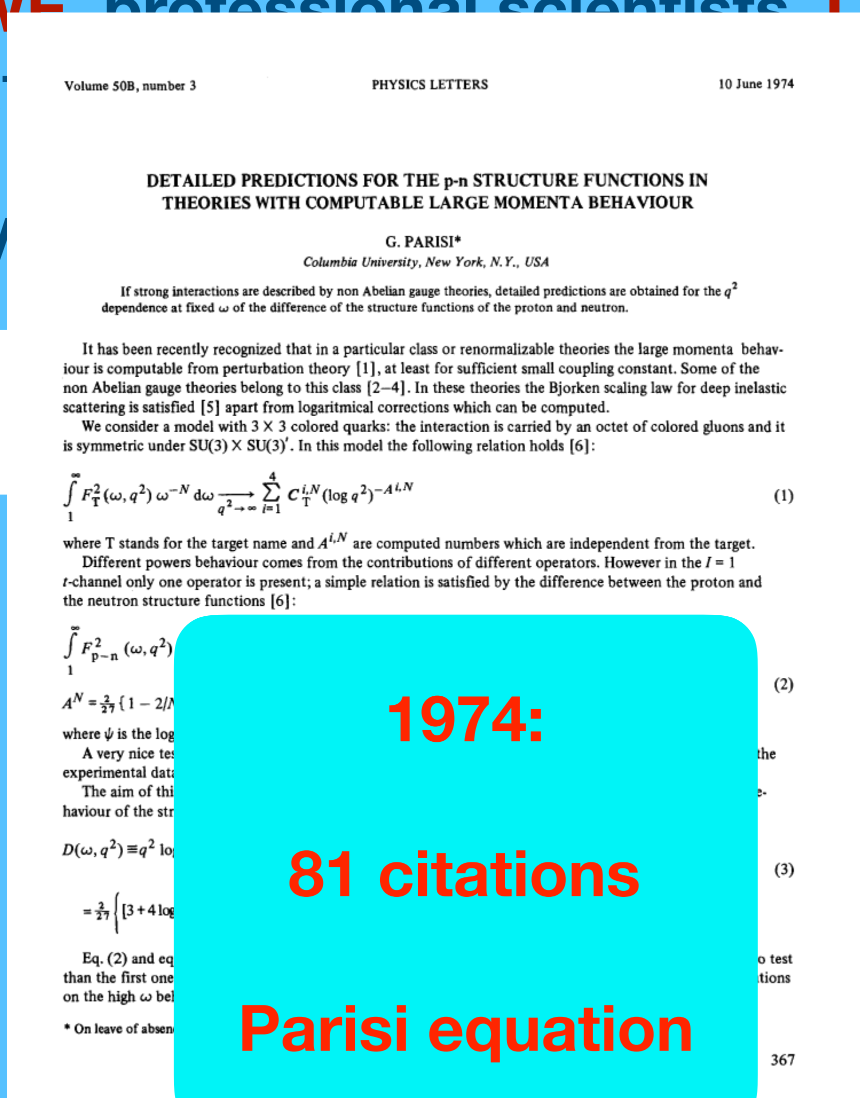

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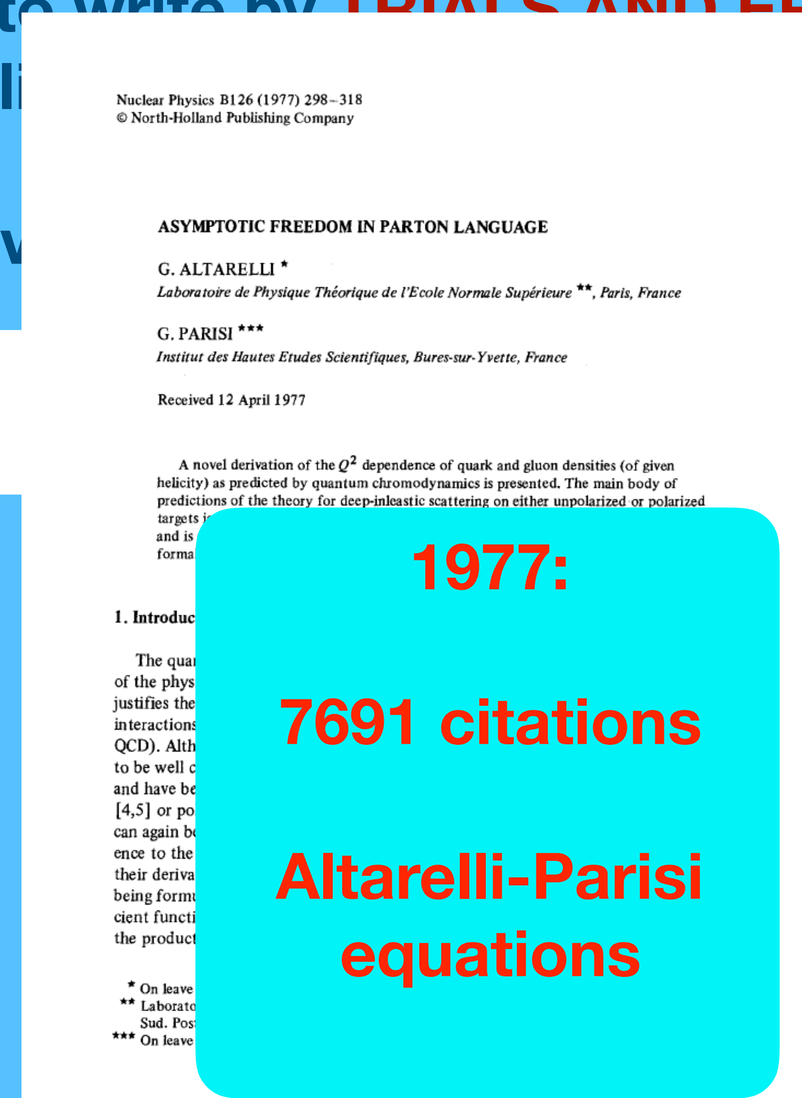

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1. Introduc...

The quar... of the phys... justifies the... interactions... QCD). Alth... to be well c... and have be... [4,5] or po... can again b... ence to the... their deriva... being form... cient functi... the product...

* On leave...
** Laborato... Sud. Pos...
*** On leave...

1977:

7691 citations

Altarelli-Parisi equations

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Many of us NEVER LEARN! You can be a very good scientist and a poor writer….

However,

we may learn from more experienced professional scientists

and

we may learn from more experienced professional writers

A Pulitzer Prize's suggestion

The 2006 Pulitzer Prize's winner Cormac McCarthy wrote a basic set of rules (suggestions…) on how to write a scientific article (in english)

Nature **574**, 441-442 (2019)

Some of them:

On the choice of the subject:

Decide on your paper's theme and two or three points you want every reader to remember. This theme and these points form the single thread that runs through your piece.

On simplicity:

If something isn't needed to help the reader to understand the main theme, omit it.
Keep sentences short, simply constructed and direct.
Concise, clear sentences work well for scientific explanations.

On the style:

Inject questions and less-formal language to break up tone and maintain a friendly feeling. […] Similarly, use a personal tone because it can help to engage a reader. If you must talk about arbitrary colours of an abstract sphere, it's more gripping to speak of this sphere as a red balloon or a blue billiard ball.

Maybe the most important: Just enjoy writing.

Not everybody enjoys writing!

Accelerated learning

Our main objective is that you may learn
the basic rules to write your Master's Thesis
by this summer…

Our final goal is to have a uniform (minimum) level in the Theses,
so as to simplify reading both for referees and normal readers
(this may be useful for us to read your theses, and for you to sell your thesis
outside the academy)

Starting from a "standard recipe", you may then evolve into your
own scientific style

General view

1. Two classes on basic rules to write the Master's thesis
2. Practical exercise: organising the Thesis (email submission)
3. Correction of the practical exercise (either by mail or skype?)
4. Presentation to the class of one or two exercises
5. My opinion on the usage of ChatGPT-like software
6. One class on basic rules to present your Master's thesis

Outline of the lectures

1. **STARTING**
   1. Choosing a language
   2. Choosing an editing language
   3. Choosing an editor

2. **ORGANIZATION OF THE THESIS**
   1. Understanding your subject
   2. What is “old”
   3. Appendices
   4. What is “new”
   5. Introduction and conclusions

3. **GRAPHICS AND EQUATIONS**
   1. Drawing and inserting plots
   2. Explaining plots (captions!)
   3. Equations

4. **REFERENCING**

1.

Outline of the lectures

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    5. Introduction and conclusions

1.

3. GRAPHICS AND EQUATIONS
    1. Drawing and inserting plots
    2. Explaining plots (captions!)
    3. Equations

4. REFERENCING

What this class it is not

We are not teaching you to write

We are not teaching you the language you use to write:
scientists write in a non-uniform language
that approximately resembles English

We are not teaching you physics

Part I: STARTING

1. Choose a language to write

Possible choices:

ENGLISH

CASTELLANO

VALENCIÁ

Part I: STARTING

1. Choose a language to write

Possible choices:

ENGLISH

CASTELLANO

VALENCIÁ

I strongly suggest ENGLISH:

1. It is the (current) language of science
2. You read books and articles in english
3. It may be your first (or last) chance to write in english
4. Your thesis will be easier to show outside (to do a PhD abroad, to go to a private company, ...)

Part I: STARTING

2. Choose a editing language

Possible choices:

NONE

Part I: STARTING

2. Choose a editing language

Possible choices:

NONE

There is only one choice possible:

LATEX

MAC: TEXSHOP https://pages.uoregon.edu/koch/texshop/

WINDOWS: MIKTEX https://miktex.org/download

LINUX: TEXLive (depends on which Linux)
https://repology.org/project/texlive/versions

Part I: STARTING

3. Choose an editor

This is up to you
(however, most Latex releases have their own editor)

Part II:ORGANIZATION

1. Understanding your subject

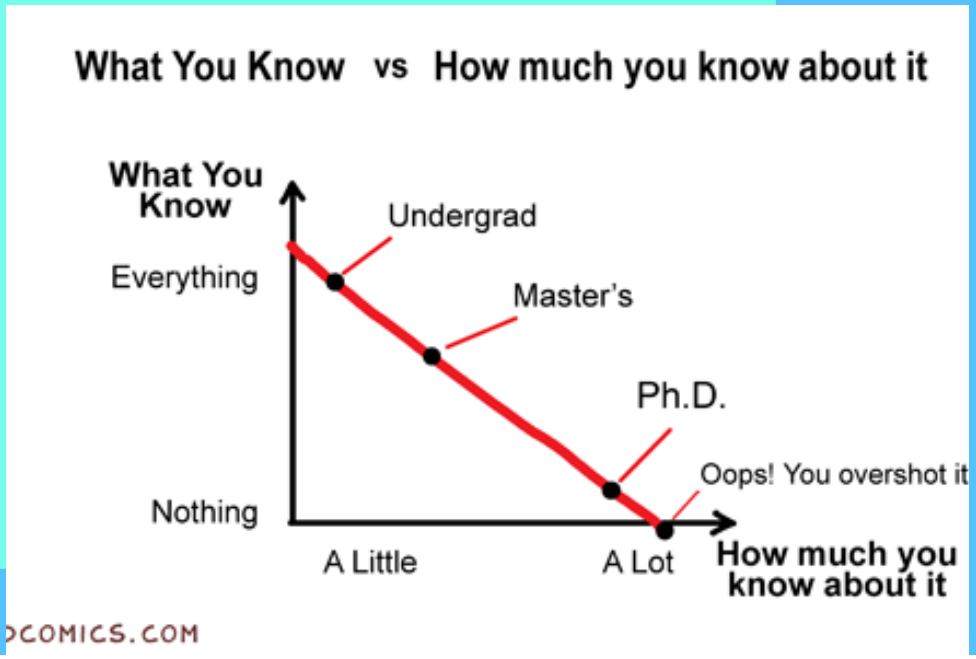
Usually, you and your advisor are the two persons that understand most of your thesis

Part II:ORGANIZATION

1. Understanding your subject

Usually, you and your advisor are the two persons that understand most of your thesis

Sometimes, only your advisor understand (most of) your thesis



Part II:ORGANIZATION

1. Understanding your subject

Usually, you and your advisor are the two persons that understand most of your thesis

The rest of the physicists that read your thesis divide into:
those that know the subject
and those that do not know the subject

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The jury that will examine you will be composed by both

Part II:ORGANIZATION

r subject

WRITE FOR THE LATTER GROUP!

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Part II:ORGANIZATION

1. Understanding your subject

You should imagine that those that read

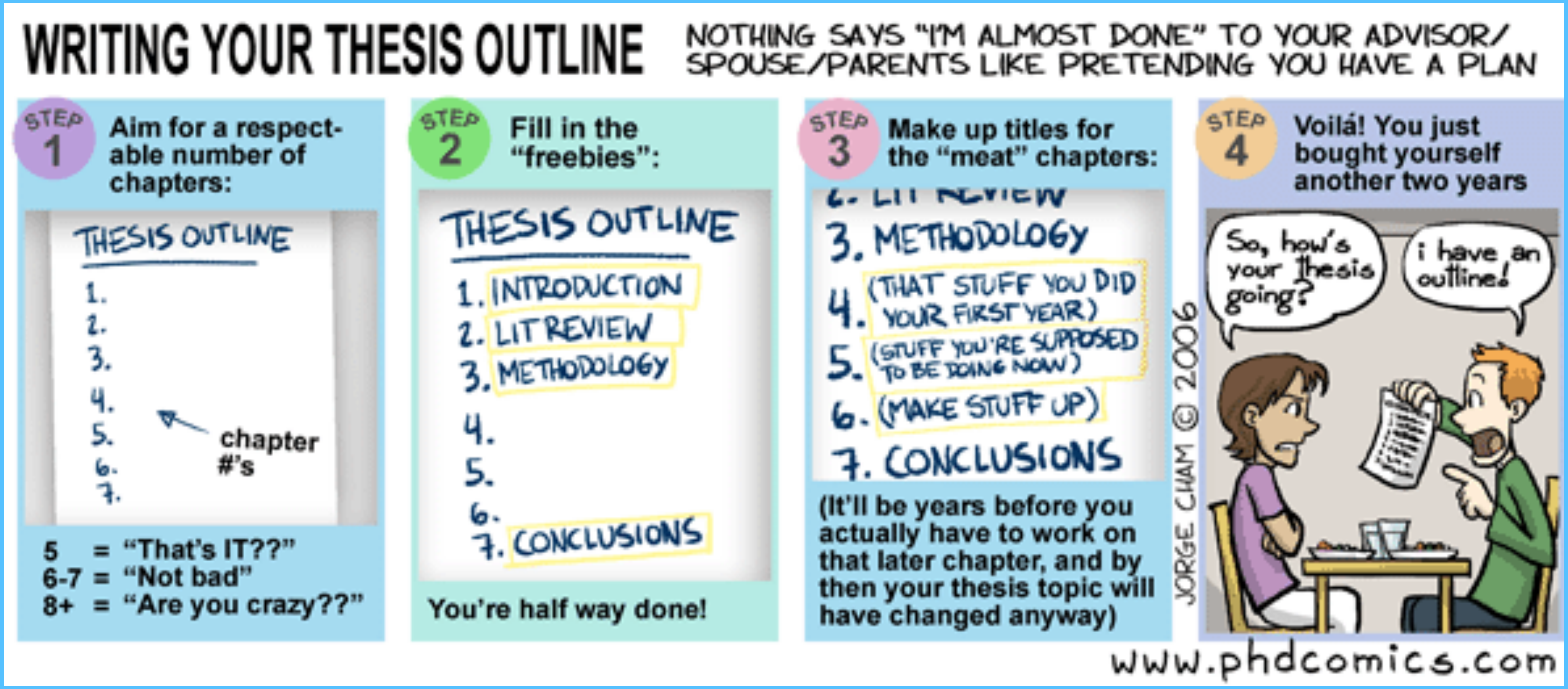
DO NOT KNOW DEEPLY THE SUBJECT
OF YOUR THESIS
(give an overview of the subject)

but

THEY KNOW AND UNDERSTAND THE BASICS
(do not start with undergraduate stuff)

Part II:ORGANIZATION

1. Understanding your subject



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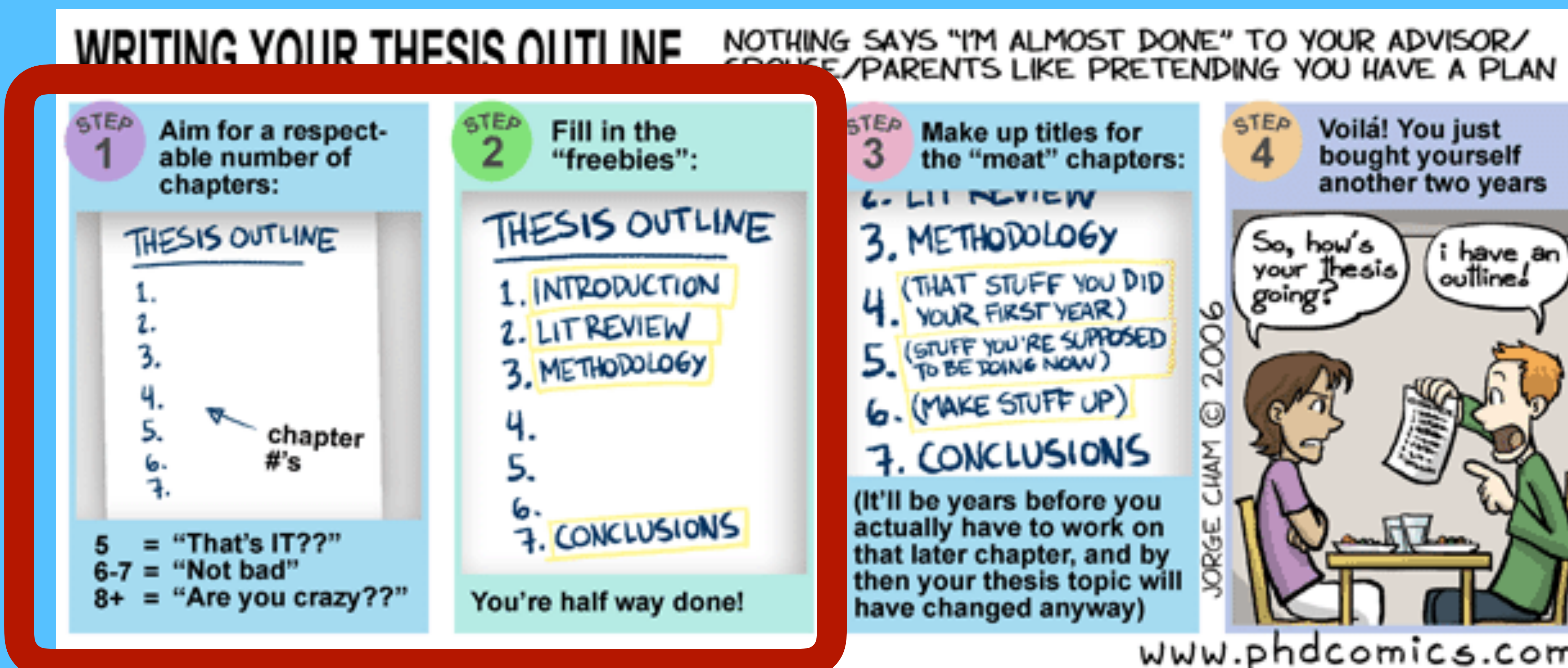

Part II:ORGANIZATION

An example from old theses

Thesis on SUSY

Contents

Part II:ORGANIZATION

An example from old theses

Introduction (motivation)

Thesis on SUSY

Contents

Part II:ORGANIZATION

An example from old theses

Introduction/ Motivation

Thesis on SUSY

“ Lil’ ” review

Contents

Part II:ORGANIZATION

Another example from old theses

Thesis on GR

Contents

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Another example from old theses

Introduction (motivation)

Thesis on GR

“ Lil’ ” review

Contents

Part II:ORGANIZATION

Introduction/Motivation: 3-6 pages

“Old” Literature: 10 to 20 pages
(from textbooks and articles)

START FROM HERE! START NOW!

Your stuff: 10 to 20 pages

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START FROM HERE! START NOW!

Your stuff: 10 to 20 pages

SECOND PART TO WRITE…
(third if you have appendices)

Part II:ORGANIZATION

Introduction/Motivation: 3-6 pages

MOST IMPORTANT PART OF THE THESIS!
LAST TO WRITE!

“Old” Literature: 10 to 20 pages
(from textbooks and articles)

START FROM HERE! START NOW!

Your stuff: 10 to 20 pages

SECOND PART TO WRITE…
(third if you have appendices)

First: What is “old”

You should determine which amount
of basic information is needed
to introduce the subject

Who is your reader: a physicist
that understand what you are doing,
but do not know the
basic literature on the subject
(except for textbooks)

First: What is “old”

Example: Thesis on some topic in General Relativity

Do not explain what is General Relativity from scratch

If you need some non-standard formalism, introduce it

First: What is “old”

Example: Thesis on some topic in General Relativity

Do not explain what is General Relativity from scratch

If you need some non-standard formalism, introduce it

STANDARD: 3 pages

First: What is "old"

Example: Thesis on some topic in General Relativity

Do not explain what is General Relativity from scratch

If you need some non-standard formalism, introduce it

STANDARD: 3 pages

NON-STANDARD: ~10-15 pages

First: no Cut&Paste

This part of the thesis is the place where it is most probable to take a short-cut:
Cut&Pasting from holy books and articles

First: no Cut&Paste

This part of the thesis is the place where it is most probable to take a short-cut:
Cut&Pasting from holy books and articles

A sensible excuse:
how may I write something about THIS better than THEM?

First: no Cut&Paste

This part of the thesis is the place where it is most probable to take a short-cut:
Cut&Pasting from holy books and articles

A sensible excuse:
how may I write something about THIS better than THEM?

This is NOT ALLOWED!
It is better to read the holy sources,
try to understand and
TRY TO WRITE BY YOURSELF

First: no Cut&Paste

https://top-papers.com/how-to-avoid-plagiarism-in-research-papers/

1. **Paraphrasing: your own words, same concept**
2. **Citing: (small) text from other paper [citenumber]**
3. **Quoting: “(complete) text from other paper” [citenumber]**

Second: Appendices

They are the place where you must move
TECHNICAL STUFF
that you used but is:

A) boring to read in the main text
B) something that may be skipped

Thesis on Quantum Systems

Appendices **38**

Second: Appendices

They are the place where you must move
TECHNICAL STUFF
that you used but is:

A) boring to read in the main text

B) something that may be skipped

As many as you need….

No more than a couple of pages each

ems

Appendices 38

Second: Appendices

These are the place where you must move
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A) boring to read in the main text
B) something that may be skipped

As many as you need….

Appendices 38

Thesis on Quantum Systems

Write these SECOND! TOMORROW!

Third: Your “new” stuff

It must be very clear
WHAT is NEW, and WHAT is NOT NEW

A typical question at the defense:

“Ok, very nice. But….
Can you explain me PRECISELY which is the difference between what YOU have done and the LITERATURE?”

Third: Your "new" stuff

Literature:
first chapters

INTRODUCE
WHAT IS OLD

You should have written this first; it is useful for you to explain differences

Your work:
last chapters

Third: Your “new” stuff

Literature:
first chapters

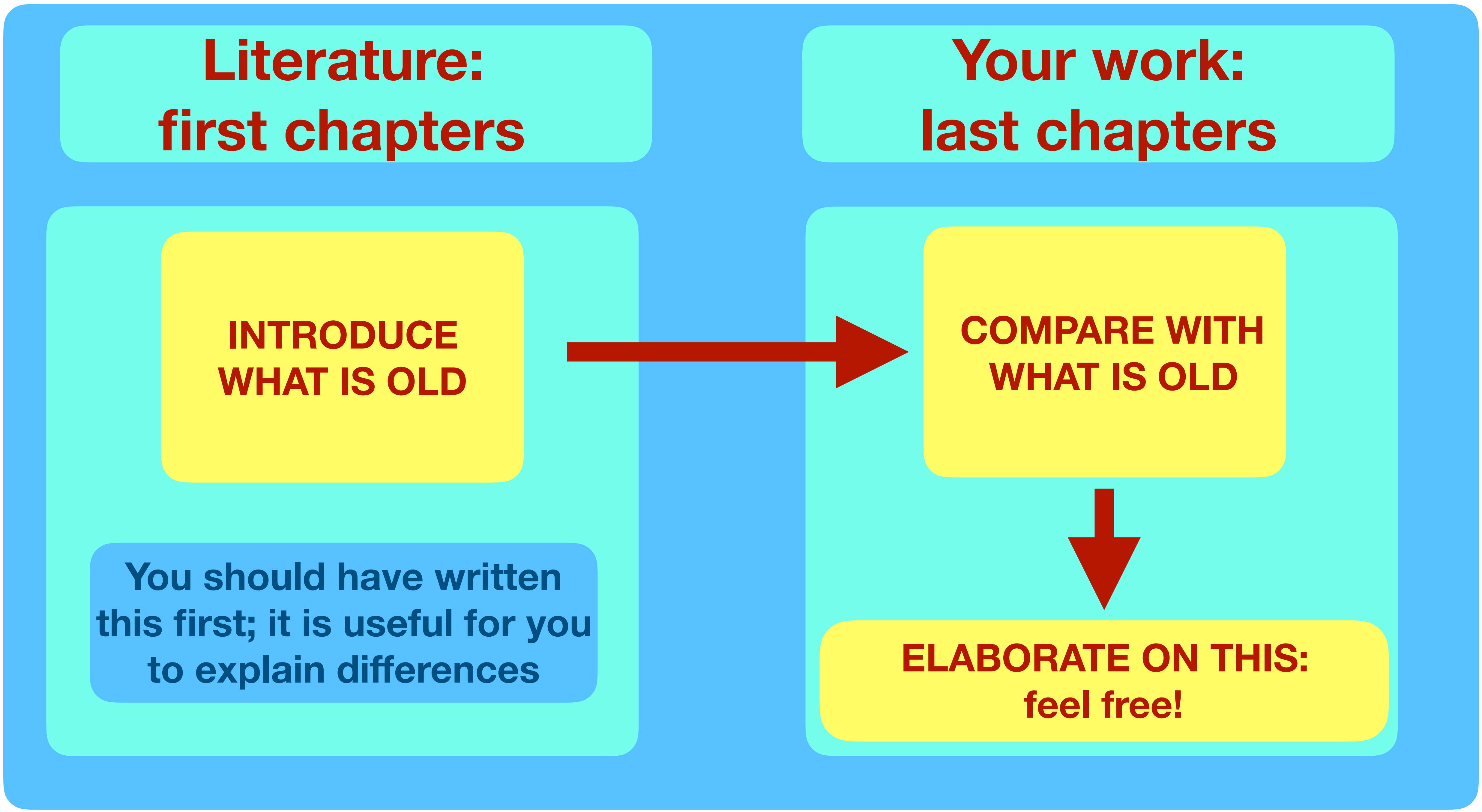
INTRODUCE
WHAT IS OLD

You should have written this first; it is useful for you to explain differences

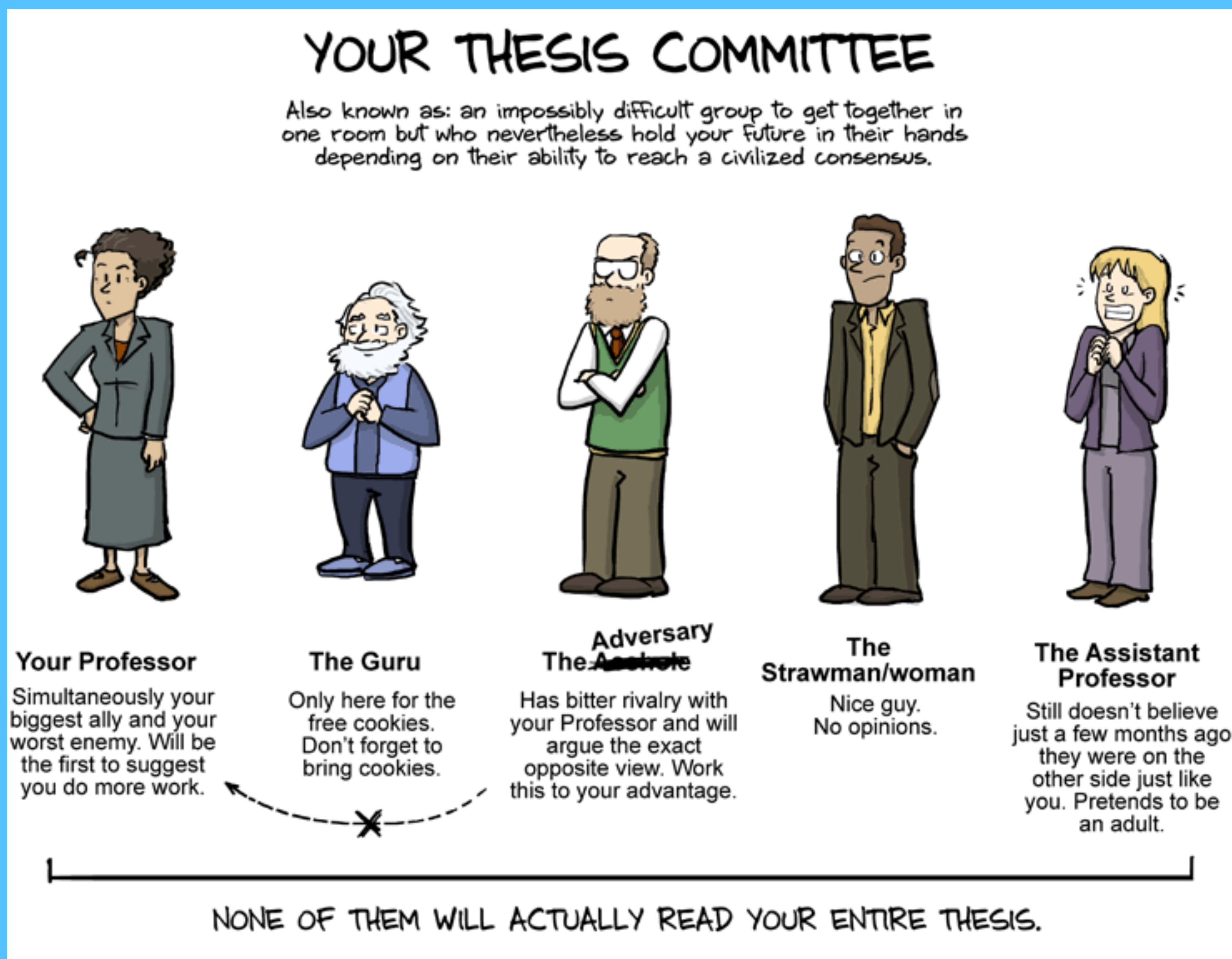
Your work:
last chapters

COMPARE WITH
WHAT IS OLD

Third: Your “new” stuff



Four: Introduction



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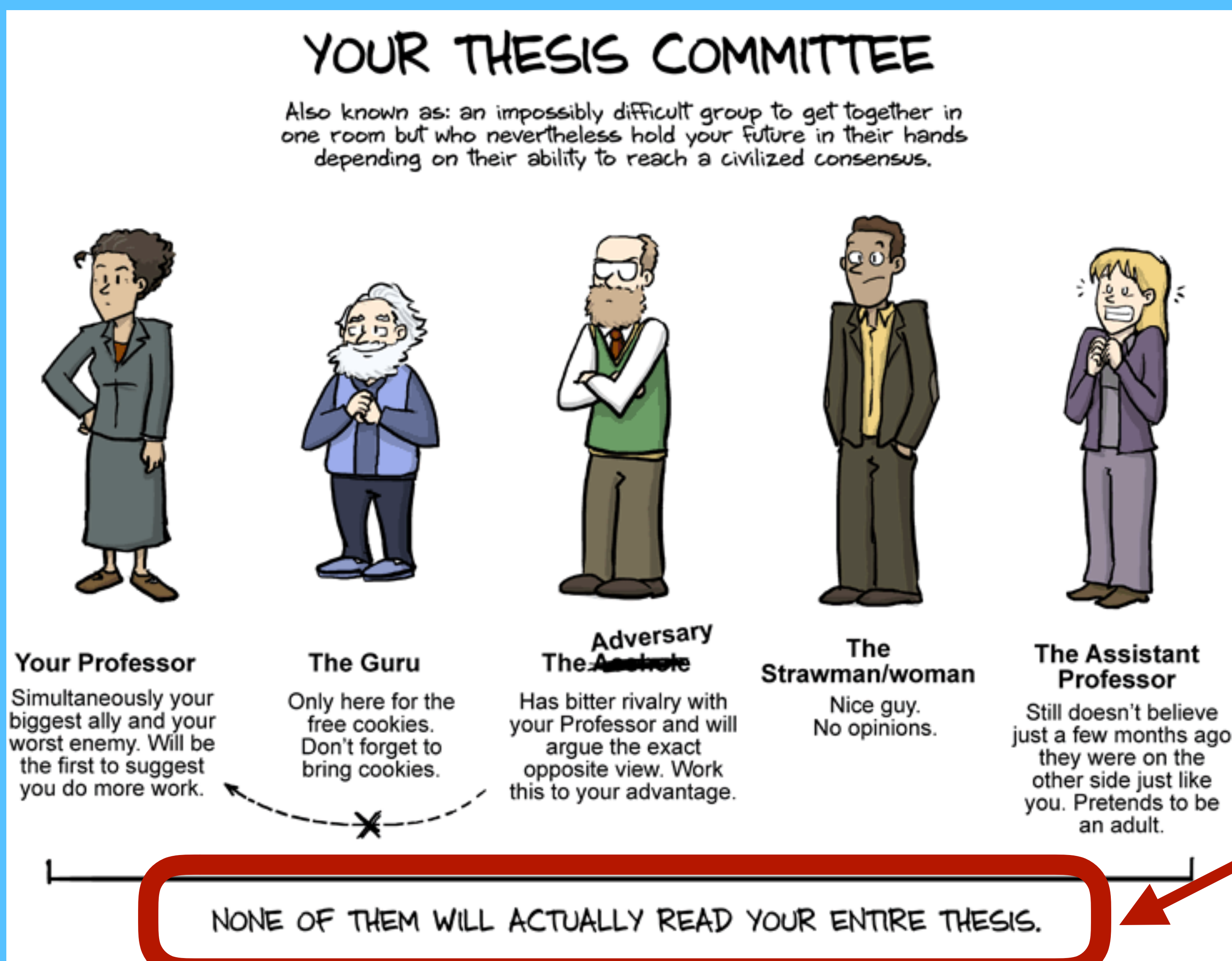

This sounds as a joke, but many times overlaps one-to-one with reality

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Organization of the thesis: "In Chapt. 1 I review ….; in Chapt. 2…."

Five: Conclusions

It is a short **summary of the thesis:**
remind shortly the motivation and the results
with respect to the literature

This is the place to insert your work as
just **one single brick in a big construction**
to be carried over many years

Use a few words to explain possible future development,
“beyond the scope of this thesis.”