IPM C3 STEM

On sentence construction and linguistic features in writing

Table of content

1. Introduction

1.1. A general comment about coherence, cohesion and language features

In my opinion the most important thing about academic or scientific writing is learning how to form cohesive and coherent sentences and paragraphs. In these notes we focus on developing simple and complex, short and long sentences, along with the use of certain linguistic features, all of which support the flow and development of scientific idea through language. The development of paragraphs as a whole will be addressed in another lesson.

The idea of linguistic features will be addressed in the next section, but basically refer to specific English language words or phrasing which allow for certain semantic effects. Such features have the effect of i) signposting was is to come, ii) signalling specific turns in content, for example when changing the focus from one idea to another idea, iii) expressing connections between ideas or exceptions to ideas, iv) stating possibilities, v) stating opinions, vi) referencing what was previously said, or what was said by someone else, etc.

The use of linguistic features in sentences then allows us to develop short, medium and long sentences, as well as simple and complex sentences. This combination of sentence length and complexity not only makes it easier for the reader to understand your work, but also creates a stylistic effect which makes reading pleasurable.

1.2. Exercise 1

Consider the following sentences. based on your current understanding about sentence structure, what can you say about these sentences?

i) I repeated the experiment 10 times.

ii) I repeated the experiment 10 times and obtained the same results.

iii) I repeated the experiment 10 times and obtained the same results, to within an accuracy of 0.1%.

iv) I repeated the experiment 10 times and obtained the same results, to within an accuracy of 0.1% despite my equipment being 20 years old.

v) I repeated the experiment 10 times and obtained the same results, to within an accuracy of 0.1% despite my equipment being 20 years old and my experience in experimental physics being rusty.

vi) For our experiment neodymium magnets of different shapes were used.

vii) For our experiment neodymium magnets of different shapes were used along with steel balls.

viii) For our experiment neodymium magnets of different shapes (rectangular, cylindrical and spherical, with two different sizes for the rectangular magnets) were used along with and steel balls of different sizes.

ix) [the magnetic cannon] allows one to study the laws of physics related to magnetism

x) [the magnetic cannon] allows one to study the laws of physics related to magnetism, collision, dynamics and classical mechanics.

xi) Although relatively simple, [the magnetic cannon] allows one to study the laws of physics related to magnetism, collision, dynamics and classical mechanics.

(Sentences vi) to xi) taken or adapted from Magkos, Gabritchidze, Patatoukos (2017)).

1.3. Exercise 2

Which of the three texts below reads in too bitty or fragmented a manner? Which is most difficult in terms of having to carry multiple ideas?

i) Whilst electricity and magnetism, which were studied extensively by Faraday in the nineteenth century and formalised mathematically by Maxwell in his famous equations (these actually consisting of 20 equations, which have now been reduced to 4 equations in modern times) seem to be two different phenomena they are actually different aspects of what is now known to be the electromagnetic field.

ii) Whilst electricity and magnetism seem to be two different phenomena, they are actually different aspects of what is now known to be the electromagnetic field. Faraday studies these phenomena extensively, and Maxwell used Faraday's results to develop the relevant mathematical equations.

iii) Electricity is one aspect of the electromagnetic field. Magnetism is another aspect of the electromagnetic field. Faraday studies these phenomena extensively. Maxwell formalised them mathematically. Maxwell developed 20 equations to connect electricity and magnetism. Maxwell's 20 equations have been reduced to 4 equations. These 4 equations are the modern versions of Maxwell's equations.

Ultimately. we do not want to write text consisting only of short, sharp sentences. This makes for very jerky reading. Neither do we want to write text consisting solely of sentences 5 lines long. This would make it very difficult to carry the main and subordinate ideas of the sentence.

2. On sentence construction

We now come to one of the two major aspects of writing, namely sentence construction (the other one being paragraph development). In this section we look at sentence length and structure so as to be able to use short and long sentences, simple and complex sentences. The terms "simple" and "complex" (and another type called "compound") *refer to the grammatical structure of the sentences, not to the level of difficulty of the scientific content*.

2.1. Simple sentences

Consider the following sentences:

The Earth revolves around the Sun.	The function is continuous.
The Bohr model of the atom involves the idea of energy levels.	The cathode ray was deflected.
We perform an analysis of stiffened panels.	Analysing the torque effects of a simply supported beam.
The distribution of force is called mechanical stress.	Water is made up of two different elements.

The sentences above are the simplest of sentence constructions. Simple sentences can be defined as follows:

- grammatical definition: These sentences contain a single clause;
- content-based definition: These sentences contain a single main idea, or state a single action or effect.

The emphasis here is on "single": Single clause, single idea, single action, single effect, etc.

Watch out not to write a paragraph as a list of simple sentences. This makes the reading of text either jerky or juddery, or like a list of items. Whatever the effect, such text can become quite heavy going, tedious and/or boring to read.

Example 1

Notice the difference in ease and flow of language and readability of the following two texts:

Version 1: Downgrading Pluto - Simple-sentence version

The solar system has 8 planets. The solar system used to have 9 planets. How did this come to be? The nature of a "planet" was redefined. One criteria for a planet is that it orbits the Sun. Another criteria for a planet is that it is mostly round. There are other criteria. Pluto does not satisfy all the criteria.

These criteria had to be accepted by professional astronomers. Members of the International Astronomical voted to accept them. Some astronomers did not agree with the result. They still class Pluto as a planet.

Version 2: Downgrading Pluto - Multiple sentence-type version

The solar system used to have 9 planets but now it officially has 8 planets. How did this come to be? The nature of a "planet" was redefined according to new criteria which would better reflect the current understanding of planetary formation. The three criteria which now define a planet are that it orbits the Sun, that it is mostly round, and that it "has cleared the neighbourhood around its orbit." Since Pluto does not satisfy the last criteria it is no longer considered a planet.

These criteria had to be accepted by professional astronomers. The organisation representing them is the International Astronomical (IAU), and its was the members of the IAU who voted to accept these new criteria. Despite this, some astronomers did not agree with the result. They still class Pluto as a planet.

(Quote taken from https://www.iau.org/public/themes/pluto/)

Example 2 (optional): Mathematics

Below are two texts I have written on the topic of continuity as understood in mathematics. Which version do you consider is easier to read? Which version do you consider is better written? (these are two different questions, and can/will have two different answers).

Version 1: Simple-sentence version

Continuity was understood from the time of the ancients up to the 19th century. Continuity means continuity of unbroken space. Unbroken space is translated geometrically as continuous lines. It is also translated as continuous curves. It is also translated as continuous angles. It is also translated as continuous areas. It is also translated as continuous volumes, etc. Geometry is based on continuity. Lines are continuous. Curves are continuous. Angles are continuous. Areas are continuous regions of space. Volumes are continuous regions of space.

When we draw a line we are performing an action. This action takes place through space. Also, when we draw a line we are performing another action. This action is action through time. The line is drawn over a continuous space. Also, the line is drawn over a continuous period of time. Continuity is built into our environment of time. Continuity is also built into our environment of space. Mathematics needs to take account of continuity.

Version 2: On the idea of continuity in mathematics: multiple sentence-type version

Continuity as understood from the time of the ancients up to the 19th century was continuity of unbroken space and time. Unbroken space was translated geometrically as continuous lines, curves, angles, areas, volumes, etc. It is clear that geometry is fundamentally based on continuity. Lines are continuous. Curves are continuous. Angles (as in the angular opening between two lines) are continuous. Areas and volumes are continuous regions of space.

More than this, when we draw a line or a curve we are performing an action through space and time. The line or curve is drawn over a continuous space and over a continuous period of time. So it seems as if continuity is built into our environment of time and space, and that any mathematics needs to take account of continuity.

Notice that in the second version of the text I still used a sequence of simple sentences (at the end of the first paragraph). This was deliberate, and for effect. I wanted to emphasise the idea that continuity is everywhere in geometry (and, by inference, that one cannot escape this), and I demonstrated the emphasis by using a sequence of simple sentences.

2.2. Compound sentences

Consider the following sentences. How are they similar and different from the simple sentences presented in the previous section?

i) Electricity and magnetism are part of the same unified field;

ii) If electricity and magnetism were truly independent phenomena, then a magnet could not induce an electric field as it passes through metal coils.

iii) Whilst electricity and magnetism seem to be completely different phenomena, they are actually different manifestations of what is now known to be the electromagnetic field.

The above are examples of compound sentences. We use compound sentences to express a connection between, or opposition of, two independent ideas of equal importance or significance. We could write a compound sentence linking three or more independent ideas, but in practice we don't do this (we will see why later on). Then, in order to write a compound sentence connecting two equally important ideas we use what is known as *coordinating conjunctions* or *correlative conjunctions*.

The words/terms "and", "if ... then", "whilst ... they are actually" in the above examples are conjunction words/terms. They act to make relevant connections, or show opposition, between ideas as well indicating the strength or degree of connection. For example i) we have "and" as conjunction, for example ii) we have "if ... then" as conjunction (we could also have had "if ... then ... otherwise"), and for example iii) we have "whilst ... they are actually ..." as conjunction. Note that the examples above are quite straightforward. In particular, compound and complex sentences can be more complicated than those shown above. We will see this when we analysis some texts.

Compound sentences can be defined as follows:

- grammatical definition: These sentences contain two or more independent clauses joined into one sentence using specific (conjunction) words;
- content-based definition: These sentences contain two or more independent scientific idea joined into one sentence using specific (conjunction) words;

Note that compound sentences can be written as two or more simple sentences.

For example,

1) "The Earth and Mars revolve around the Sun". This could have been written as "The Earth revolves around the Sun. Mars revolves around the Sun".
2) "The Earth revolves around the Sun but the moon does not". This could have been written as "The Earth revolves around the Sun. The moon does not revolve around the Sun".

Exercise: Rewrite examples i) to iii) above as a sequence of simple sentences.

Conjunctions are used everywhere in one's writing because they are extremely useful linguistically in making reading flow better, and in linking different ideas in ways which help us emphasise concepts the way we want to (there will be more on this as we progress through the notes). I would go as far as saying that it is not possible to write anything readable without using conjunctions. It is not possible to write anything linguistically readable, nor conceptually understandable without conjunctions (as well as other language features to be seen in section 4 below). In terms of an extended text we have already seen examples of compound sentences in the "Version 2" example texts above. You yourselves have undoubtedly used different types of conjunctions to a greater or lesser extent in your writing so far.

2.2.1. Coordinating conjunctions

Coordinating conjunction are conjunction which allow us to connect two ideas which can be expressed separately as two separate sentences but which we decide to express as a single sentence. We normally do this when the two separate ideas we are describing have equal weight, importance or significance in the science.

The most common coordinating conjunctions are *since*, *because*, *and*, *nor*, *but, however*, *or*, *yet*, and *so, hence, therefore*, but there are plenty of others ("despite", and "indeed" just come to mind). Without the regular use of some of these it is impossible to write cohesively, both grammatically and semantically.

Simple examples of their use include:

- **Because** I wanted to study the laws of motion under uniform acceleration, I decided to use an inclined plane as my apparatus;
- I studied the laws of motion under uniform acceleration by using an inclined plane **and** a stopwatch;
- With his newly constructed telescope Galileo was able to observe the moons of Jupiter. **However**, some of his colleagues were not convinced that the bright specs he was looking at were moons;
- I want to study the laws of motion under uniform acceleration **so** I set up an inclined-plane experiment;
- **Despite** the primitive technology of the day, Galileo was still able to construct a telescope of sufficient quality to see the moons of Jupiter.

Exercise: In each of the examples above can you identify the two separate, independent ideas which are being connected or compared? Write these two ideas as separate, stand-alone, self-contained sentences.

2.2.2. Correlative conjunctions

Correlative conjunctions are *pairs of words* which connect two or more ideas of equal importance or significance, or they compare different facets of one idea where the facets are of equal importance.

- **Both** electricity **and** magnetism are manifestations of the electromagnetic field. (connection between E and EM field, and B and EM field)
- **Whether or not** electricity is a manifestation of the electromagnetic field is a debatable point. (comparing E with EM field, in the sense "Is it or isn't it?")
- **Either** electricity and magnetism can be unified into one single theory **or** they can't.
- **Neither** electricity **nor** magnetism can be considered as unrelated phenomena.
- **Rather than** seeing electricity and magnetism as two unrelated phenomena we can see them as two different manifestations of the same phenomenon.
- **Not only** is electricity one manifestation of the electromagnetic field **but so** is magnetism.

2.3. Complex sentences

Consider the following sentences. How are they similar and different from simple sentences or compound sentences presented in the previous sections?

i) Saturn, with its associated moons and ring system, revolves around the Sun;

ii) Cathode rays can be deflected provided they contain electrically charged particles;

iii) Provided cathode rays contains electrically charged particle these rays can be deflected;

iv) NASA's Voyager 2 spacecraft, which was launched in 1977 but was never expected to last this long, was launched on a trajectory towards the gas giants Jupiter and Saturn to enable further encounters with Uranus and Neptune, these being ice giants. (adapted from https://en.wikipedia.org/wiki/Voyager_2)

The above are examples of complex sentences. We use complex sentences to express detail to a main idea. Such detail could be removed from the sentence without affecting the grammar of the sentences or the validity of the scientific idea. The only effect of removing detail from a complex sentence would be to make the sentence convey the scientific idea in a more general sense. Then, to write a sentence having one main idea with additional detail we use what is known as *subordinating conjunctions or subordinating clause.*

For example, if we have the complex sentence

"Saturn, with its associated moons and ring system, revolves around the Sun",

and we correctly remove the dependent clause what remains is a simply sentence which is still scientifically correct. So, the previous example could be made into a simple sentence by removing the dependent clause "with its associated moons and ring system" to give us

"Saturn revolves around the Sun".

This sentence is scientifically correct. It simply contains less detail. However, if we had written something like "the associated moons and ring system, revolves around the Sun" then this would be scientifically incorrect.

For

- ii) and iii) above: the subordinate clause / extra detail is given by "provided they contain electrically charged particles". The resulting simple sentence would be "Cathode rays can be deflected". This is scientifically correct. It just doesn't explain why this is the case;

- iv) the simple sentence version would be "NASA's Voyager 2 spacecraft was launched on a trajectory towards the gas giants Jupiter and Saturn." Is this correct? Or is there a more simple sentence to iv) than this? Or does this simple sentence miss out on the main single clause/idea?

Complex sentences can be defined as follows:

- grammatical definition: These sentences contain one independent clause and one dependent clause using specific (conjunction) words;
- content-based definition: These sentences contain one independent scientific idea with extra phrasing relating to this idea which acts to add more detail or information to the idea.

2.3.1. Subordinating conjunctions

Subordinating conjunctions are those which connect two aspects or ideas which *do not* have the same importance or weight. In terms of scientific writing a subordinating conjunction implies that you have a main, central or primary scientific concept you are describing, along with a description of a secondary concept which adds detail to the main idea of the sentence. The description of this secondary idea is the subordinate clause.

Subordinating clauses can be omitted from a sentence without altering the scientific validity of the sentence. All that deleting a subordinating clause then does is to shift the precision of a theme from specific to general.

a) "**Although** the Earth and the moon seem very close, it takes four days to get there by Saturn V rocket." The main idea here is that it takes four days to reach the moon (by Saturn V rockets). The secondary idea is that the Earth and moon seem very close.

b) "**In order for** me to land on the moon, I need to train as an astronaut." The primary idea here is that I need to train as an astronaut. The secondary idea is that ...

c) "**By the time** I land on the moon I will have gone through extensive training." The main idea her is that ...; The secondary idea is that ...

d) "**Even though** I have gone to the moon it will be ages before I return." The main idea her is that ...; The secondary idea is that ...

e) "**Provided** the weather is good I will be able to take off to go to the moon." The main idea her is that ...; The secondary idea is that ...

f) "**Whilst** I have not yet received the appropriate training, I will not be able to land on the moon." The main idea her is that ...; The secondary idea is that ...

g) "**Before** anyone can land on the moon they need to receive the proper training." The main idea her is that ...; The secondary idea is that ...

h) "I need the proper training **in order** to be able to land on the moon." The main idea her is that ...; The secondary idea is that ...

Be careful how you use the conjunction to order the primary and secondary ideas. If you use the conjunction incorrectly you may end up highlighting the secondary idea instead of the primary idea. This problem is illustrated below:

"In order for me to land on the moon, I need to train as an astronaut."

versus

"In order for me to train as an astronaut, I need to land on the moon."

Both of these sentences are grammatically correct but the second sentence is not logical. The same can be said of the following:

"Whilst electricity and magnetism seem to be two unrelated phenomena,
they are actually different aspects of the same EM field."

versus

"Whilst electricity and magnetism seem to be different aspects of the same EM field,
they are actually two unrelated phenomena."

Again, both of these sentences are grammatically correct but we know the second sentence to be scientifically incorrect.

Other examples include

1) "What Bill doesn't know about rocket fuselage engineering isn't worth knowing" vs "Bill isn't worth knowing";

2) "The distribution of force across a section is called stress" vs "Force across a section is called stress" vs "The distribution across a section is called stress";

3) "If a force $F(t)$ acts on a viscously damped spring-mass system […], the equation of motion can be obtained using Newton's second law […]." vs "If a force $F(t)$ acts on a spring-mass system […], the equation of motion can be obtained using Newton's second

law [...].” vs “If a force $F(t)$ acts on a viscous system [...], the equation of motion can be obtained [...].”

4) “Let f be a function in **R**, and let c be a point in the domain of f. The function f is continuous at c if the limit as f approaches c equals the value of f at c” vs “Let f be a function in **R**, and let c be a point in the domain of f. The function f is continuous at c if the limit as f approaches c” vs “Let f be a function in **R**, and let c be a point. The function f is continuous at c if the limit as f approaches c equals the value of f at c” vs Let f be a function, and let c be a point in the domain of f. The function f is continuous at c if the limit as f approaches c equals the value of f at c”.

The moral of the story is that you have to be careful when removing clauses.

Are you removing a subordinate clause or a main clause?

Will removing a subordinate clauses still produce a scientifically correct sentence?

This is where you need to know your science.

2.3.2. Conjunctions to do with time

Words such as *when, after, before, since, while, once, until, as soon as*, are examples of subordinating conjunctions which can be used to connect an action or event to a point in time. The following examples illustrate the use of time dependent conjunctions:

- “In 1989 the Magellan orbiter launched on a reconnaissance mission to Venus, and by 1990 it was in orbit. Over the next five years the orbiter returned near-global radar images, gravity data and a topographic map of the second planet from the sun. [...] **When** Magellan plunged to Venus’s surface in 1994, NASA’s support for Venus spacecraft died with it. **Since then**, scientists have submitted more than 25 proposals for return missions to Venus, and although some of those received high rankings from review boards, none were approved. [...] The “habitable zone” is the region around a star where a rocky planet could have liquid water on its surface. Earth, obviously, is in this zone. Venus, we think, used to be in this zone—for quite a **while**, in fact.” (Darby Dyar, Smrekar, and Kane (2019));

- “Firstly, **after** preliminary rinsing of the tubing, the instrument is subjected to standard mass-to-charge axis calibration giving to the student the sense of direct infusion HRMS instrument preparation. [...] **After** the session, the student calculates the exact mass associated to elemental compositions using freely available elemental composition calculator tools” (Bouza et al (2022). Note that the style/use of English here is not standard. This is because the authors are not native English writers/speakers).

- “The authors concluded that the nanotube volume fraction had a much more significant effect on composite stiffness **when** operating above the glass transition temperature. […]. The fundamental theory at the basis of the frequency-dependent dynamic models of VDM dates back to the 18th century **when** the behavior of viscoelastic materials was studied by Boltzmann, Coriolis, Gauss, and Maxwell.” (Zhou et al (2016));
- “Particle simulation of plasmas, employed **since** the 1960s, provides a self-consistent, fully kinetic representation of general plasmas. […]” (Verboncoeur (2005));
- “In this situation, you have what is called "paired" data, because each measurement beforehand is paired with a measurement **afterwards**.” (Greenhalgh (1997)).

2.4. Important comment

The ability to use simple, compound and complex sentences in a varied manner makes the difference between text that is easy to understand and a pleasure to read, and text that is not. Such sentence structures allow for the smooth flow of reading, the logical development of scientific ideas, and the easy uptake of scientific meaning. Proficient use of these features is not as simple as it may seem, not because any one specific feature is difficult to use but because you will need to develop the skill at using so many of these over such a large scale of text in order to make your text as a whole read smoothly and fluidly.

Since it is not practical to list or memorise dozens of sentence structures and language features we will not be able to address all of them here. You may find other types of linguistic features as you read through the literature. A more practical approach will therefore be to read as many papers as possible in order to get a feel for what cohesive writing looks like via the use of linguistic features. Repeated exposure to, and experience at, this will then make easier for you to write in your preferred linguistic style. You may already have an ability to write cohesively. Whatever you current ability, aim to be able to write cohesively at an expert standard.

Note: Since this course is not an EAP or English grammar course you do not need to memorise the different grammatical terms of "simple", "compound", and "complex" sentences. I have used these only to broadly section the different types of sentences that can be written.

3. Examples of the structure of complex sentences: Clause-structure / dependency trees

Using what I call a clause structure or dependency tree (this name is my own invention and does not come from any literature (as far as I know)) we can visualise the structure of a sentence according to the levels of subordinate clauses or dependent phrases it has. This section is presented only for information and learning purposes. It will help you better understand the nature of the structure of compound and complex sentences. However, you will not need to perform such an analysis in your final research report. All you will need to do is know how to write simple, compound and complex sentences in such a way as to produce fluid and cohesive writing.

The following examples are adapted from the work of a 2023 UCL pre-Master's student on graphene-based oxygen sensors for detecting dissolved oxygen.

Example 1

The sentence is "Among techniques previously described, one type of electrochemical transducer called Clark oxygen sensor has been used extensively for the measurement of biological fluids oxygen concentration."

Clause structure / dependency tree

- Among techniques previously described, one type of electrochemical transducer
  - called Clark oxygen sensor
- has been used extensively
  - for the measurement of biological fluids oxygen concentration.

Example 2

The sentence is "Graphene has become a popular material for electromechanical sensors due to its large surface area, high mechanical strength, high elasticity and thermal conductivity."

Clause structure / dependency tree

- Graphene has become a popular material for electromechanical sensors
    - due to its large surface area,
    - high mechanical strength,
    - high elasticity
    - and thermal conductivity

Example 3

Sentence is “Graphene is formed by a single layer of carbon atoms.”

Clause structure / dependency tree

- Graphene is formed by a single layer of carbon atoms.

Another example

Original sentences: “A well-known method called Solid Neoplasms Hypoxia, a method which can control the metabolism, survival and spread of lethal cancer cells, is known to be reliable when treating cancer. Furthermore, it is already proved that bone healing process is highly sensitive about oxygenation status of bone tissue and some brain diseases also relative to oxygen concentration in brain tissue.”

Clause structure / dependency tree

- A well-known method
    - called Solid Neoplasms Hypoxia,
        - a method which can control the metabolism, survival
        - and spread of lethal cancer cells,
- is known to be reliable
    - when treating cancer.
- Furthermore, it is already proved that bone healing process is highly sensitive
    - about oxygenation status of bone tissue
- and some brain diseases
    - also relative to oxygen concentration
        - in brain tissue.

Example 4

The sentence is "Not only would progress towards understanding the process of mathematical hypothesis formation and confirmation contribute to our philosophical understanding of the nature of mathematics, it might even be of help and solace to those mathematicians actively engaged in the axiom search." (P. Maddy, "Believing the Axioms I", *The Journal of Symbolic Logic*, Jun., 1988, Vol. 53, No. 2 (Jun., 1988), pp. 481-511)

Clause structure / dependency tree

- Not only would progress towards understanding
  - the process of
- mathematical hypothesis formation
- and confirmation
- contribute to our
  - philosophical
- understanding
  - of the nature of mathematics,
- it might even be of help
- and solace
- to those mathematicians
  - actively engaged in the axiom search.

4. More extensive examples of clause-structure / dependency trees (optional)

The following are examples of the clause structure and/or dependency tree for text taken from the literature. Note that you may see the structures or dependencies of the original texts differently to the way in which I have presented these. This is ok. Our course is not to create such trees/dependencies but to use these to see the possible ways in which simple, compound, complex sentences may be structured. See such possibilities then allows us to construct sentence structure *as we choose* in order to communicate science in the way we wish to.

1) From “Astrophysical Black Holes: A Compact Pedagogical Review”, Bambi, C. *Annalen der Physik* (Berlin) 2018, Vol 530, 1700430

<u>*Original text*</u>

A black hole is, roughly speaking, a region of the spacetime in which gravity is so strong that nothing, nor even light, can escape. The event horizon is the boundary of such a region. The possibility of the existence of extremely compact objects such that their strong gravitational field could prevent the escape of light was first discussed by John Michell and Pierre-Simon Laplace at the end of the 18th century in the context of Newtonian mechanics.

<u>*Clause-structure / dependency tree*</u>

- A black hole is,
  - roughly speaking,
- a region of the spacetime
  - in which gravity is so strong that nothing,
    - nor even light,
  - can escape.
- The event horizon is the boundary of such a region.
- The possibility of the existence of extremely compact objects
  - such that their strong gravitational field could prevent the escape of light
- was first discussed by John Michell and Pierre-Simon Laplace
  - at the end of the 18th century
    - in the context of Newtonian mechanics.

2) From “Plate Tectonics, Sea-Floor Spreading, and Continental Drift”, Robert S. Dietz, *Journal of College Science Teaching*, Vol. 2, No. 1 (OCTOBER 1972), pp. 16-19

<u>*Original text*</u>

The plate tectonics concept holds that the earth is divided into about eight rigid spherical caps 100 km thick, riding on the weak asthenosphere and in which the continents are embedded and drift as passive passengers. We can visualize the ideal plate as rectangular, although perhaps only the Indian plate attains this simplicity. Along one edge there is a subduction zone, usually marked by a trench, where the cold crustal plate dives steeply into the earth's mantle, reaching a depth of 700 km before being fully resorbed.

Clause-structure / dependency tree

- The plate tectonics concept holds that the earth is divided into about eight rigid spherical caps
    - 100 km thick,
- riding on the weak asthenosphere
- and in which the continents are embedded
- and drift as passive passengers.
- We can visualize the ideal plate as rectangular,
    - although perhaps only the Indian plate attains this simplicity.
- Along one edge there is a subduction zone,
    - usually marked by a trench,
        - where the cold crustal plate dives steeply into the earth's mantle,
- reaching a depth of 700 km before being fully resorbed.

3) From “Confirmation of intuitions about the behavior of beams and trusses”, Clive L. Dym, Harry E. Williams, International Journal of Mechanical Engineering Education, Volume 41, Number 3 (July 2013).

Original text

Intuition is central to successful modeling of structural behavior and often develops from simple structural models. Two modelling assumptions are widely quoted: that sufficiently large number of discrete loads can be treated as a uniform load, and that trusses behave like beams. While these ideas are commonplace, their formal justification does not seem to appear in the literature. For example, many introductory texts on structures indicate that all of the top (or bottom) chords of a truss are in tension (or compression), depending on the loading and the supports, but they do not explicitly demonstrate the beam-like behavior of a truss. Again, these two instances of structural intuition are well known, but their actual demonstrations do not seem to be available.

Clause-structure / dependency tree

- Intuition is central to successful modeling of structural behavior
    - and often develops from simple structural models
- Two modelling assumptions are widely quoted:
    - that sufficiently large number of discrete loads can be treated as a uniform load,
    - and that trusses behave like beams.

    - While these ideas are commonplace,
- their formal justification does not seem to appear in the literature.
- For example, many introductory texts on structures indicate that all of the top (or bottom) chords of a truss are in tension (or compression),
    - depending on the loading
    - and the supports,
- but they do not explicitly demonstrate the beam-like behavior of a truss.
- Again, these two instances
    - of structural intuition
- are well known,
- but their actual demonstrations do not seem to be available.

4) From "Dynamics of relativistic solitons", Daniela Farina and Sergei V Bulanov (2005) Plasma Phys. Control. Fusion **47** A73-A80.

Original text

Relativistic solitons are self-trapped, finite-sized, electromagnetic waves of relativistic intensity that propagate without diffraction spreading. They have been predicted theoretically within the relativistic fluid approximation, and have been observed in multi-dimensional particle-in-cell simulations of laser pulse interaction with the plasma. This paper reviews many theoretical results on relativistic solitons in electron–ion plasmas. The theoretical investigation of relativistic solitons in electron–ion plasmas is a relatively old problem in plasma physics, which has been treated by many authors in the past, and has recently gained new attention in [1–16]. Since a significant portion of the overall electromagnetic energy is trapped in the form of solitons, solitary waves can play an important role in the laser–plasma interaction.

Clause-tree structure

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5. Examples from the literature

Using the agreed upon chemistry paper, we will analyse said paper for its sentence structures.

6. References

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