Academic Communication
in (Astro)Physics

Lecture 3: Good Style II

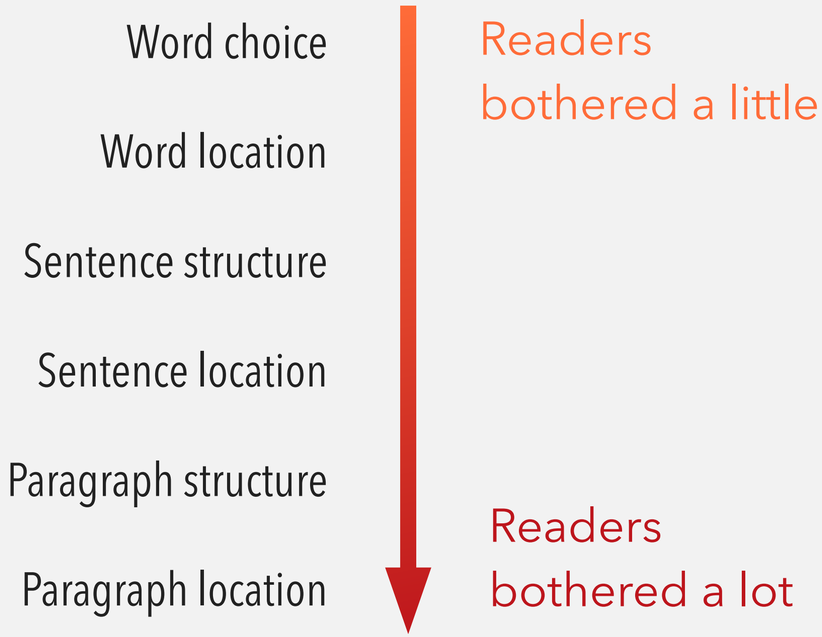
Internal Structure

Paragraphs & Sentences

Substance ⇔ Structure

Readers have relatively fixed expectations about where in the structure of prose they will encounter particular items of its substance.

It is more important to logically organize and present one's ideas than to worry about perfect grammatical form or word choice (though those are important too!).



Organize your paragraphs

Make paragraphs the unit of composition. – Strunk & White

Paragraph = group of sentences on a **single topic**. **Ask yourself: What is this paragraph about?**

Sentences need to be logically organized and positioned.

Power Positions

First Sentence

Introduces the topic, i.e., what the paragraph is about.

The topic sentence may also contain a transition from a previous paragraph or section.

Last Sentence

Summarize, draw a conclusion, or emphasize something important.

Body (Middle) of the Paragraph

Develop the topic; present supporting facts, arguments, examples, and information.

Organize the sentences logically, be mindful of the flow.

Topic sentence(s) [Issue]

- A well-constructed paragraph discusses a single main idea. This idea should be stated in the “topic sentence”.
- The topic sentence gives an overview of the paragraph.
- Often appears at the start of the paragraph (first sentence, one of the first sentences, if another one is used to link to previous paragraph).
- Each following sentence must relate to the topic sentence.
- In a well-written paper in which all the topic sentences are in the first power position, a reader can simply scan the topic sentences alone and know what the paper is about (i.e., using the first sentences as stepping stones when skimming).

Example: issue (1)

A standard approach to model consistently the emission from stars and dust in galaxies has been to solve the radiative transfer equation for idealized (bulge + disc) spatial distributions of stars and dust (e.g. Rowan-Robinson 1980; Efstathiou & Rowan- Robinson 1990; Popescu et al. 2000; Gordon et al. 2001; Misiriotis et al. 2001; Misselt et al. 2001). Early models of this type did not include the evolution of stellar populations. Silva et al. (1998) were the first to couple radiative transfer through a dusty ISM and the spectral (and even chemical) evolution of stellar populations. Their model also accounts for the fact that stars are born in dense molecular clouds, which dissipate after some time, and hence, that newly born stars are more attenuated than older stars (see also, e.g. Charlot & Fall 2000; Tuffs et al. 2004). This type of sophisticated model is useful to interpret in detail the emission from individual galaxies in terms of constraints on stellar populations and the spatial distribution and physical properties of the dust. However, because of the complexity of radiative transfer computations, it is not optimized to derive statistical constraints from observations of large samples of galaxies.

da Cunha et al. (2008)

Example: issue (2)

It is worth pausing here to emphasize the important implications of the finite lifetime of the birth clouds. As mentioned in Section 1, emission lines appear to be more attenuated than the continuum radiation in starburst galaxies. This led Calzetti (1997) to suggest that ultraviolet-bright stars must be somehow physically detached from the gas they ionize. In our model, the lines produced in H II regions and the non-ionizing continuum radiation from young stars are attenuated in the same way by dust in the outer H I envelopes of the birth clouds and the ambient ISM. However, since the birth clouds have a finite lifetime, the non-ionizing continuum radiation from stars that live longer than the birth clouds is attenuated only by the ambient ISM. The ultraviolet and optical continuum radiation, therefore, appears to be less attenuated than the lines. This can be seen clearly in Figures 3c and 4c from the rise in the Ha/Hb ratio accompanying the drop in the Ha equivalent width at nearly constant ultraviolet spectral slope as the effective absorption optical depth of the birth clouds increases above unity. Thus, the finite lifetime of the birth clouds is a key ingredient for resolving the apparent discrepancy between the attenuation of line and continuum photons in starburst galaxies.

Charlot & Fall (2000)

Example: issue (3)

The influence of stellar winds and supernovae on the interstellar medium (ISM) of galaxies, generally dubbed “feedback,” has been regarded as an important ingredient in galaxy evolution since the 1970s (Larson 1974; Larson & Dinerstein 1975; White & Rees 1978). Feedback is believed to play a critical role in regulating star formation by reheating the cold ISM and by physically removing gas from the disk and possibly the halo via galactic winds. Various lines of observational evidence have established that large-scale outflows of gas are ubiquitous among the most actively star-forming galaxies at low and high redshift (e.g., Lehnert & Heckman 1996; Dahlem et al. 1998; Rupke et al. 2002; Shapley et al. 2001; Frye et al. 2002). However, detailed studies of winds in nearby starbursts have shown them to be a complex, multiphase, hydrodynamical phenomenon with the majority of the energy and newly synthesized metals existing in the hard-to-observe coronal and hot phases ($T=10^5$–10^7 K; e.g., Strickland et al. 2002). This complexity has prevented both a direct assessment of the cosmological impact of galactic winds and the development of physically accurate prescriptions for incorporating feedback into semianalytical and numerical models of galaxy formation.

Tremonti et al. (2004)

Middle of the paragraph [Development]

- After presenting the issue, expand on it in the development. One good way to write this is to lay out well defined steps that lead to some conclusion.
- Details are organized depending on the purpose of the information contained in the paragraph. For example:
    - least to most (or most to least) important; in an announced order (first, second, third); chronologically
    - compare-and-contrast pattern or problem-and-solution pattern.
- Each sentence will generally begin with a transition word that helps the reader navigate the information.

Last sentence [Conclusion]

- Note: short paragraphs often only have Issue + Development; that’s ok.
- It can be a summary: serves as a comprehension check for the reader.
- It can pose a question or make a speculation: it leaves the reader with something to ponder.
- The last sentence is a power position: use it to emphasize what the reader should take away from the paragraph.

Example: conclusion (1)

A standard approach to model consistently the emission from stars and dust in galaxies has been to solve the radiative transfer equation for idealized (bulge + disc) spatial distributions of stars and dust (e.g. Rowan-Robinson 1980; Efstathiou & Rowan- Robinson 1990; Popescu et al. 2000; Gordon et al. 2001; Misiriotis et al. 2001; Misselt et al. 2001). Early models of this type did not include the evolution of stellar populations. Silva et al. (1998) were the first to couple radiative transfer through a dusty ISM and the spectral (and even chemical) evolution of stellar populations. Their model also accounts for the fact that stars are born in dense molecular clouds, which dissipate after some time, and hence, that newly born stars are more attenuated than older stars (see also, e.g. Charlot & Fall 2000; Tuffs et al. 2004). This type of sophisticated model is useful to interpret in detail the emission from individual galaxies in terms of constraints on stellar populations and the spatial distribution and physical properties of the dust. However, because of the complexity of radiative transfer computations, it is not optimized to derive statistical constraints from observations of large samples of galaxies.

da Cunha et al. (2008)

Example: conclusion (2)

It is worth pausing here to emphasize the important implications of the finite lifetime of the birth clouds. As mentioned in Section 1, emission lines appear to be more attenuated than the continuum radiation in starburst galaxies. This led Calzetti (1997) to suggest that ultraviolet-bright stars must be somehow physically detached from the gas they ionize. In our model, the lines produced in H II regions and the non-ionizing continuum radiation from young stars are attenuated in the same way by dust in the outer H I envelopes of the birth clouds and the ambient ISM. However, since the birth clouds have a finite lifetime, the non-ionizing continuum radiation from stars that live longer than the birth clouds is attenuated only by the ambient ISM. The ultraviolet and optical continuum radiation, therefore, appears to be less attenuated than the lines. This can be seen clearly in Figures 3c and 4c from the rise in the Ha/Hb ratio accompanying the drop in the Ha equivalent width at nearly constant ultraviolet spectral slope as the effective absorption optical depth of the birth clouds increases above unity. Thus, the finite lifetime of the birth clouds is a key ingredient for resolving the apparent discrepancy between the attenuation of line and continuum photons in starburst galaxies.

Charlot & Fall (2000)

Is this a paragraph?

However, these numerical simulations have been computed independently for star and planet so far, while acquired spectra are the result of the natural coupling at each phase along the planet orbit. A next step forward is needed: coupling stellar and planetary 3D model dynamics during the transit.

NO:

- “However” implies that the first sentence is linked to a previous concept, which was not fully explored.
- These two sentences do not provide enough information in their own right to be a paragraph.

What makes a good paragraph?

UNITY
it's about one single idea/topic

ORDER
information is presented logically

COHERENCE
all the concepts go well together

COMPLETENESS
it is wrapped up?

...Ideally, a paragraph should tell a story!

Story structure

Most patient audience

Least patient audience

OCAR
Opening, Challenge, Action, Resolution

Specialist journal (e.g., ApJ)

fits into IMRaD
(Introduction, Methods, Results and Discussion)

ABCDE
Action, Background, Development, Climax, Ending

Proposals

LDR
Lead, Development, Resolution

Generalist journals (e.g., Nature)

LD
Lead, Development

News stories
(core of the story in the first few sentences, OCR in the first section or sentence; the rest fills up the story)

Design your paragraphs

Point-first paragraphs:

You make an argument and then flesh it out.

TS-D/LD structure – you could skip along, reading the 1st sentence of each paragraph, and still get the essence; like stepping stones through the paper.

- simple, clean, works well for most jobs: they should dominate your writing;
- particularly good for describing methods and results;
- note: can use several sentences to build to the point, rather than a single topic sentence.
- often used in short paragraphs

Example: LD paragraph

We determine stellar mass-to-light ratios and nebular metallicities for our sample galaxies from the SDSS spectra. The spectra are obtained with two 320-fiber spectrographs mounted on the SDSS 2.5 m telescope. Fibers $3''$ in diameter are manually plugged into custom-drilled aluminum plates mounted at the focal plane of the telescope. The spectra are exposed for 45 minutes or until a fiducial signal-to-noise ratio (S/N) is reached. The median S/N per pixel for galaxies in the main sample is $\sim$14. The spectra are processed by an automated pipeline (D. J. Schlegel et al. 2004, in preparation) that flux and wavelength calibrates the data from 3800 to 9200 Å. The instrumental resolution is $R \equiv \lambda/\delta\lambda = 1850$–$2200$ (FWHM $\sim$ 2.4 Å at 5000 Å).

Tremonti et al. (2004)

Design your paragraphs

Point-last paragraphs:

Sometimes you need to assemble an argument, pulling threads together to weave them into a conclusion: for this, use a point-last structure (LDR or OCAR).

These sorts of paragraphs are useful for complex story structures.

- **LDR paragraph:** opens with an argument and then develops it (similar to LD), but then it wraps it up with a synthesis; it's strong both at opening and resolution [note: this does not mean the L and R sentences say the same thing exactly!]
- **OCAR paragraph:** opening sentence introduces the issue without framing an argument — it just sets the stage. The last sentence synthesizes the material to make the conclusion.
- often used in long paragraphs because they benefit from a resolution to tie them together and remind the reader of the point.

Example: LDR paragraph

We remove galaxies harboring an active galactic nucleus (AGN) from our sample using the traditional line diagnostic diagram [N II]/Hα versus [O III]/Hβ (Baldwin et al. 1981; Veilleux & Osterbrock 1987). The division between star-forming galaxies and AGNs has been calibrated theoretically by Kewley et al. (2001). We adopt the slightly modified formula used by Kauffmann et al. (2003c), which provides a more conservative approach to selecting star-forming galaxies (see their Fig. 1). We apply this criterion where we detect [O III] with 3 σ significance (and Hβ, Hα, and [N II] at 5 σ, as specified earlier). To avoid biasing ourselves against high-metallicity galaxies that have intrinsically weak [O III], we also include objects with [O III] $< 3\ \sigma$ and $\log([\text{N II}]/\text{H}\alpha) < -0.4$ in our star-forming sample. These galaxies comprise $\sim$16% of our final sample. The fraction of emission-line galaxies that we reject because of AGN contamination is $\sim$33%.

Tremonti et al. (2004)

Example: OCAR paragraph

It is worth pausing here to emphasize the important implications of the finite lifetime of the birth clouds. As mentioned in Section 1, emission lines appear to be more attenuated than the continuum radiation in starburst galaxies. This led Calzetti (1997) to suggest that ultraviolet-bright stars must be somehow physically detached from the gas they ionize. In our model, the lines produced in H II regions and the non-ionizing continuum radiation from young stars are attenuated in the same way by dust in the outer H I envelopes of the birth clouds and the ambient ISM. However, since the birth clouds have a finite lifetime, the non-ionizing continuum radiation from stars that live longer than the birth clouds is attenuated only by the ambient ISM. The ultraviolet and optical continuum radiation, therefore, appears to be less attenuated than the lines. This can be seen clearly in Figures 3c and 4c from the rise in the Ha/Hb ratio accompanying the drop in the Ha equivalent width at nearly constant ultraviolet spectral slope as the effective absorption optical depth of the birth clouds increases above unity. Thus, the finite lifetime of the birth clouds is a key ingredient for resolving the apparent discrepancy between the attenuation of line and continuum photons in starburst galaxies.

Charlot & Fall (2000)

Example: OCAR paragraph

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Charlot & Fall (2000)

Design your paragraphs

It’s better when the structure is apparent, because if it is unclear, then the point may be, too.
Don’t write point-nowhere paragraphs!

Bad paragraphs lack a coherent structure and therefore can seem confusing and pointless, e.g., “stream of consciousness” writing.

The key to writing good paragraphs, and fixing bad ones, is the same as for other writing problems.

Identify:
1) who the story is about,
2) your point, and
3) where you should make it.

Put the critical pieces of information in the right places,
and use the rest of the text to tie them together smoothly.

How to write coherent & clear paragraphs

- Use consistent order
- Use consistent point of view (keep subject the same for different sentences in the paragraph)
- Make your sentences cohesive
- Use key terms to create continuity. Repeat them exactly and early, and link them.
- Use transitions to indicate logical relationships between sentences.
- Make your writing concise.

Use a consistent point of view

Be consistent with your point of view or person.

Switching the subject (e.g., from birds to seeds), or the person (e.g., from third to second person) disorients the reader.

These findings suggest that **patients** returning from tropical countries who show very itchy linear or serpiginous tracked skin eruptions should be tested for larvae of animal hookworms. **Topical ointments** with an antiparasitic drug such as thiabendazole should be used to treat patients with this disease, known as cutaneous larva migrans. These **patients** often also suffer from complications of the disease such as impetigo and allergic reactions.	These findings suggest that **patients** returning from tropical countries who show very itchy linear or serpiginous tracked skin eruptions should be tested for larvae of animal hookworms. **Patients** with this disease, known as cutaneous larva migrans, should be treated with antiparasitic drug such as thiabendazole. These **patients** often also suffer from complications of the disease such as impetigo and allergic reactions.

Make sentences cohesive

Within a paragraph, sentences need not only to be logically organized but also to be cohesive, i.e., they need to fit neatly and logically together.

Good word location creates good “flow” of a paragraph.

Some ways to keep sentences cohesive:

- placing information provided at the end of a sentence at the beginning of the next sentence
- keeping a consistent point of view: keep subject in each sentence as the same term of category term; information in the topic position of each sentence refers back to the topic position of the topic sentence.
- paying attention to where old and new information are placed.

Yersinia contains several **species.** The cause of bubonic plague, also known as the “black death”, is **one species**, *Y. pestis*.	*Yersinia* contains several **species. One species**, *Y. pestis*, is the cause of the bubonic plague, also known as the “black death”.

Example: cohesive sentences

The Sloan Digital Sky Survey (York et al., 2000; Stoughton et al., 2002) is using a dedicated 2.5-meter wide-field telescope at the Apache Point Observatory to conduct an **imaging** and **spectroscopic** survey of about a quarter of the extragalactic sky. The **imaging** is conducted in the *u*, *g*, *r*, *i* and *z* bands (Fukugita et al., 1996; Gunn et al., 1998; Hogg et al., 2011; Smith et al., 2002), and **spectra** are obtained with a pair of multi-fiber spectrographs.

Kaufmann et al. (2003)

Use key terms to create continuity

Key terms are words or phrases used to identify **important ideas in a sentence**, a paragraph, and the paper as a whole. Usually, they are used to identify the main points in the topic sentence.

Key terms should be **clearly defined and identical throughout the paragraph** (and the document).

If you deliberately repeat key terms, your main points are emphasized and you create continuity. If key terms are omitted or replaced by another term, readers can get confused.

To assess the original conditions of crystal nucleation and growth in metamorphic rocks, it is necessary to analyze crystal distribution quantitatively. Density could potentially provide insight into the times scale of mineral growth following the thermal peak of metamorphism.	To assess the original conditions of crystal nucleation and growth in metamorphic rocks, it is necessary to analyze crystal distribution quantitatively. **Crystal distribution** could potentially provide insight into the times scale of mineral growth following the thermal peak of metamorphism.

Note: linking key terms

When you need to shift from a category to a more specific term or the other way around, key terms should be linked so continuity is not lost and the paragraph stays coherent.

To link key terms, use the category term to define the specific term.

Once a link has been established, subsequent sentences can then use the key terms or the category term.

When key terms are repeated consistently and early, good word location almost always falls right into place.

Whales, dolphins, and porpoises are mammals that lived on land before returning to the ocean about 50 million years ago. Today, the bodies of cetaceans are streamlined to glide easily through the water.	Whales, dolphins, and porpoises, **also known as cetaceans**, are mammals that lived on land before returning to the ocean about 50 million years ago. Today, the bodies of cetaceans are streamlined to glide easily through the water.

Example: key terms

It is worth pausing here to emphasize the important implications of the **finite lifetime of the birth clouds**. As mentioned in Section 1, emission lines appear to be more attenuated than the continuum radiation in starburst galaxies. This led Calzetti (1997) to suggest that ultraviolet-bright stars must be somehow physically detached from the gas they ionize. In our model, the lines produced in H II regions and the non-ionizing continuum radiation from young stars are attenuated in the same way by dust in the outer H I envelopes of the **birth clouds** and the ambient ISM. However, since the **birth clouds have a finite lifetime**, the non-ionizing continuum radiation from stars that live longer than the **birth clouds** is attenuated only by the ambient ISM. The ultraviolet and optical continuum radiation, therefore, appears to be less attenuated than the lines. This can be seen clearly in Figures 3c and 4c from the rise in the Ha/Hb ratio accompanying the drop in the Ha equivalent width at nearly constant ultraviolet spectral slope as the effective absorption optical depth of the **birth clouds** increases above unity. Thus, the **finite lifetime of the birth clouds** is a key ingredient for resolving the apparent discrepancy between the attenuation of line and continuum photons in starburst galaxies.

Charlot & Fall (2000)

Transition words

Prepare the reader for what's to come. Indicate logical transitions between the sentences. Ensure continuity within a paragraph.

- foretell **chronological order**
  first, second, third, initially, then, finally, in conclusion, thus, to conclude, to summarize, another, after, afterward, at last, …

- foretell **general to specific**
  for example, for instance, namely, specifically, to illustrate, accordingly, consequently, hence, so, therefore, thus.

- foretell **least important to most important**
  clearly, most importantly, the most serious, the most weighty, the foremost.

- foretell a **problem and a solution**
  but, however, in spite of, nevertheless, nonetheless, notwithstanding, instead, still, yet.

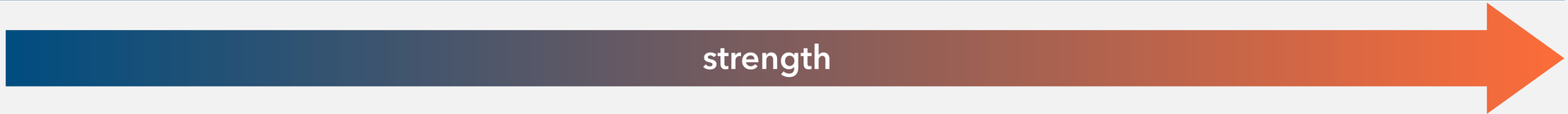
- foretell a **compare and contrast**
  similarly, also, in the same way, just as, so too, likewise, in comparison, however, in contrast, on the contrary, unlike, on the one hand… on the other hand.

Transition words, phrases, and sentences (1)

	EXAMPLE		
USE	**TRANSITION WORDS**	**TRANSITION PHRASE**	**TRANSITION SENTENCE**
Addition	again, also, further, furthermore, in addition, moreover	In addition to X, we... Besides X, ...	Further experiments showed that...
Concession	clearly, evidently, obviously, undeniably		Granted that X is...
Comparison	also, likewise, similarly	As seen in... In the same way, ...	When A is compared with B... As reported by... When compared too....
Contrast	but, however, nevertheless, nonetheless, still, yet	In contrast to A, ... On one hand,...; on the other hand, ... Despite X, ... Unlike X, ... On the contrary,	One difference is that... Although X differed...
Example	for example, specifically, namely	To illustrate X...	An example of X is that... That is, ...

Transition words, phrases, and sentences (2)

	EXAMPLE		
USE	**TRANSITION WORDS**	**TRANSITION PHRASE**	**TRANSITION SENTENCE**
Explanation	here, therefore, in short	Because of X... In this experiment...	One reason is that... Because X is...
Purpose	for this purpose	For the purpose of... To this end, ... To determine XYZ, we...	The purpose of X was to...
Result	consequently, generally, hence, therefore, thus	As a result of...	Evidence for XYZ was that...
Sequence/time	after, finally, first, later, last, meanwhile, next, now, second, then, while, subsequently	After a careful analysis of X... During centrifugation, ...	After X was completed, ... When we determined X...
Summary	in brief, in conclusion, in fact, in short, in summary	To summarize (our results), ...	As a summary of our results shows,



Transition words

Avoid transitions that are used in more casual conversation, such as:

besides (but not besides X…)
additionally
suddenly
admittedly
basically
as a matter of fact
ergo
at once

Avoid outdated terms, such as:

hitherto
notwithstanding
aforementioned
firstly (use "first" instead)
henceforth
secondly
lastly

Use transitions to link ideas, but do not overuse them.

Ensure that you are using the correct terms, especially if you are a non-native English speaker (check dictionary rather than guessing the meaning of transition words).

Example: transition words

It is worth pausing here to emphasize the important implications of the finite lifetime of the birth clouds. As mentioned in Section 1, emission lines appear to be more attenuated than the continuum radiation in starburst galaxies. This led Calzetti (1997) to suggest that ultraviolet-bright stars must be somehow physically detached from the gas they ionize. In our model, the lines produced in H II regions and the non-ionizing continuum radiation from young stars are attenuated in the same way by dust in the outer H I envelopes of the birth clouds and the ambient ISM. **However**, since the birth clouds have a finite lifetime, the non-ionizing continuum radiation from stars that live longer than the birth clouds is attenuated only by the ambient ISM. The ultraviolet and optical continuum radiation, **therefore**, appears to be less attenuated than the lines. This can be seen clearly in Figures 3c and 4c from the rise in the Ha/Hb ratio accompanying the drop in the Ha equivalent width at nearly constant ultraviolet spectral slope as the effective absorption optical depth of the birth clouds increases above unity. **Thus**, the finite lifetime of the birth clouds is a key ingredient for resolving the apparent discrepancy between the attenuation of line and continuum photons in starburst galaxies.

Charlot & Fall (2000)

Example: transition words

[…] This complexity has prevented both a direct assessment of the cosmological impact of galactic winds and the development of physically accurate prescriptions for incorporating feedback into semianalytical and numerical models of galaxy formation.

Fortunately, it is possible to obtain some quantitative information about the impact of galactic winds without a full understanding of the abstruse physics responsible for their morphology and kinematics. Galaxies that host winds powerful enough to overcome the gravitational binding energy of their halos will vent some of their metals into the intergalactic medium. **Hence**, one way of evaluating the importance of galactic winds is to look for their chemical imprint on galaxies. **However**, low metallicity is not necessarily a hallmark of wind activity. The metallicity of a galaxy is expected to depend strongly on its evolutionary state, **namely**, how much of its gas has been turned into stars. To detect metal depletion, it is **therefore** necessary to make some assumptions about the expected level of chemical enrichment based on a galaxy's star and gas content. **Of course**, other mechanisms besides winds could make a galaxy appear to be metal depleted, **for example**, the inflow of pristine gas, or the return of comparatively un-enriched material from evolved low-mass stars. **However**, these scenarios can potentially be distinguished by examining the dependence of metal depletion on dynamical mass. **To quantify** the impact of feedback on the local galaxy population, we **therefore** compare the observed metallicities of galaxies spanning a wide range in total mass to the predictions of simple chemical evolution models.

Tremonti et al. (2004)

Arrange your paragraphs

- Not only you need to make each individual paragraph cohesive, you need to have a plan for **how the paragraphs link together** to tell a story within a subsection (remember the story structures we discussed).
- **Make an outline.** Describe the function of each paragraph. Then it's just a matter of fleshing out the paragraph, rather than the whole section from scratch.
- You need to know what your **overall plan for each section** is.

Arrange your paragraphs

Arrange your paragraphs in predictable patterns that help readers move easily through a document and grasp the main points.

Some of these patterns are:

- **Chronological order:** usually works well when describing a process, for example in the *Methods* section of a scientific paper.
- **General to specific:** a logic way to provide unfamiliar information; works well for the *Introduction*. Start with a general overview of the topic, then gradually narrow to the specific focus of the paper in succeeding paragraphs.
- **Specific to general:** works well for the *Discussion* section, i.e., progress from specific findings to general implication.
- **Least important to most important:** placing more important ideas at the end can be more memorable and hence more persuasive.
- **Problem to solution:** presenting a problem or paradox early in a document and then proceed to solve it or show a novel approach to it.
- **Compare and contrast:** this ordering helps readers separate the characters while they weight in similarities or differences.

Effective internal structure

To ensure that your final pieces have an **effective internal structure**, go over them paragraph by paragraph and section by section and ask the following questions:

- Does each unit make a clear, single point?
- When several paragraphs together form a section, are the linkages among them clear?
- Has every extraneous thought that breaks the serial arc structure been removed?
- When you introduce a topic, do you resolve that discussion before introducing a new topic?
- Is every major unit of work defined by either a subhead or clear opening text?

If you can’t answer “Yes” to each of these questions, then you haven’t finished working on the structure.

Sentences: word location

A sentence tells a story, just the shortest one possible. — Joshua Schimel, *Writing Science*

Readers naturally emphasize the material that arrives at the end of a sentence – "the stress position".

Mosquitoes often carry parasites.

Topic Stress

Parasites are often carried by mosquitoes.

Topic Stress

*from now on, I will highlight sentence subjects with boldface and underline the verbs.

Topic:

- identifies the characters and the setting – who or what the story is about
- a sentence should have a single topic
- presents the context for what is to come: should be something the readers are familiar with (a.k.a. **old information**)
- putting new information at the beginning of a sentence will confuse the reader

Stress:

- endings are power positions: like the punch line of a joke
- save the end of sentences for what you want the reader to remember – save best for last
- put main message and new ideas or terms (a.k.a. **new information**) here

Sentences: word location

Establish importance

To decide the best placement of words within a sentence, it is crucial to decide what is important, what is less important, and what is not important.

In 2007, Noeske et al. reported that the star formation rates of galaxies correlate with their stellar masses.

Noeske et al. (2007) reported that the star formation rates of galaxies correlate with their stellar masses.

Emphasis on year or authors.

The star formation rates of galaxies correlate with their stellar masses (Noeske et al., 2007).

Emphasis on findings.

Ensure that, **for each sentence**:

- The backward-linking old information appears in the topic position
- The person, thing or concept whose story it is appears in the topic position
- The new, emphasis-worthy information appears in the stress position

For most readers, information in the main clause carries more weight than that in the dependent clause.

(A) Although vitamin B6 seems to reduce the risk of macular degeneration, *it may have some side effects.*

(B) *Vitamin B6 reduces the risk of macular degeneration*, but it may have some side effects.

(C) *Taking vitamin B6 may have some side effects*, but vitamin B6 also reduces the risk of macular degeneration.

(D) Although taking vitamin B6 has some side effects, *vitamin B6 reduces macular degeneration.*

Sentence version	News in main clause	News in end position	Percentage of readers who would take vitamin B6
A	– negative	– negative	30%
B	+ positive	(–) negative (dependent clause)	40%
C	– negative	(+) positive (dependent clause)	60%
D	+ positive	+ positive	70%

Note: Although word placement is more important than word choice for sentence interpretation by the reader, if a word is strong or extreme enough it can dominate the reader's attention.

(E) Although taking vitamin B6 may result in serious deformities or even death, vitamin B6 reduces macular degeneration.

What is the important statement in these sentences?

(A) Although the shape of the M-sigma relation may indicate the importance of AGN feedback in galaxies, it may also reflect the effects of galaxy mergers.

(B) The shape of the M-sigma relation may indicate the importance of AGN feedback in galaxies, but it may also reflect the effects of galaxy mergers.

(C) The shape of the M-sigma relation may reflect the effects of galaxy mergers, but it may also indicate the importance of AGN feedback in galaxies.

(D) Although the shape of the M-sigma relation may reflect the effects of galaxy mergers, it may also indicate the importance of AGN feedback in galaxies.

Making paragraphs flow

Place old, familiar, and short information at the beginning of a sentence in the topic position.
Place new, complex, or long information at the end of a sentence in the stress position.

Readers expect to see old information that links backwards at the beginning of a sentence (or paragraph) and new information at the end of a sentence (or paragraph) where it is emphasized more.

The writing "flows" much better if the information is linked through word location.

Quantum mechanics has enjoyed many successes since its formulation in the early 20th century. **It** has explained the substructure and interactions of atoms, nuclei, and subnuclear particles, and has given rise to revolutionary technologies, such as integrated circuit chips and magnetic resonance imaging. At the same time, **it** has generated puzzles that persist to this day.

- consistent subjects at the beginning of sentences
- strong verbs
- new information at the end of sentences
- (in this example quantum mechanics is already familiar to the readers)

Making paragraphs flow

Place old, familiar, and short information at the beginning of a sentence in the topic position.
Place new, complex, or long information at the end of a sentence in the stress position.

Example: introducing concepts unfamiliar to readers.

In the Great Lakes of Africa, large and diverse species **flocks of cichlid fish** have evolved rapidly. **Lake Victoria**, the largest of these lakes, had until recently at least 500 species of haplochromine cichlids. **They** were ecologically so diverse that they utilized almost all resources available to freshwater fishes in general, despite having evolved in perhaps as little as 12,400 years and from a single ancestral species. This **species flock** is the most notable example of vertebrate explosive evolution known today. Many of its **species** have vanished within two decades, which can only partly be explained by predation by the introduced Nile perch. Stenotopic rock-dwelling **cichlids**, of which there are more than 200 species, are rarely eaten by Nile perch. Yet, many such **species** have disappeared in the past 10 years.

- authors introduced the main characters, cichlid fish, by placing them at the end of the first two sentences.
- once the reader is well aware of them, cichlids (or similar terms) are subject at the beginning of the remaining sentences.

Making paragraphs flow

Place old, familiar, and short information at the beginning of a sentence in the topic position.
Place new, complex, or long information at the end of a sentence in the stress position.

Example: switching subjects in a paragraph.

Supernovae deposit enormous amounts of energy into their surroundings. **They** play a key role in the heating of their host galaxies and in the enrichment of the interstellar medium with heavy elements that form the building blocks of life. Yet, the actual **explosion mechanism** is not well understood. One **way** to study the explosion is through the dynamics of the stellar debris that comprise supernova remnants such as Cassiopeia A. **Cas A** is the 2nd youngest known supernova remnant in the Galaxy (approximately 340 years old) and is also among the brightest. **It** is well studied at radio, X-ray, infrared, and optical wavelengths and is known to have two oppositely directed jets of ejecta with expansion velocities as high as 15,000 km/s.

- the main character of the paragraph starts off as supernovae.
- At the end of the fourth sentence, we are introduced to a new character, Cassiopeia A, so we are prepared when it becomes the new subject of the next two sentences.

Errors to avoid

Misplacing old and new information is a common error in scientific writing. The results are writing that lacks "flow", and readers who miss the main points. Several ways these errors occur:

1) Writers **shift old information to the end of the sentence**, which nudges the new information to the beginning.

Wildland **fires** are disturbances that occur with long recurrence intervals and generally high severity in some forest types and with shorter intervals in and lower severity in others. For millennia, wildland **fires** have arguably been the most important disturbance process throughout many western forests. Seed **germination** and **establishment**, growth **patterns**, plant community **composition** and **structure**, **rates** of mortality, soil **productivity**, and other **properties** and **processes** of western forest ecosystems are often strongly influenced and shaped by fire disturbance regimes. Even so, perhaps the most controversial **aspect** of western land management at present is the ecology of fire and fire management.	For millennia, wildland **fires** have been arguably the most important disturbances in many western forests. In some forest types, these **fires** occur infrequently with generally high severity, while in others, **they** occur frequently with lower severity. **Fire** strongly influences many aspects of western forest ecosystems including germination and establishment of seedlings, patterns of growth, composition, and structure of plant communities, rates of mortality, and productivity of soils. Even so, of the issues western land managers face, the **ecology of fire** and **fire management** are the most controversial.

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2) Writers **repeat old information at the end** of their sentences.

Riparian forests in western North America <u>are</u> exceptionally important habitats and their ecological significance is often disproportionally important in relation to the amount of landscape they occupy. The **productivity** of riparian habitats <u>is</u> typically much higher than adjacent areas, and many species of plants and animals are restricted to riparian habitats. In areas of the arid west, **riparian forests** <u>constitute</u> less than 1% of the landscape, and yet well over 50% of the species breeding birds depend on those habitats.	**Riparian forests** in western North America <u>are</u> exceptionally important. Although they occupy only a small part of the landscape, **they** <u>are</u> much more productive than adjacent areas, and many species of plants and animals are restricted to them. For example, in the arid west, **riparian forests** <u>constitute</u> less than 1% of the landscape, yet they support well over 50% of the breeding bird species.

Errors to avoid

Misplacing old and new information is a common error in scientific writing. The results are writing that lacks "flow", and readers who miss the main points. Several ways these errors occur:

1) Writers **shift old information to the end of the sentence**, which nudges the new information to the beginning.
2) Writers **repeat old information at the end** of their sentences.
3) Writers **put the new information at the beginning** of an introductory sentence instead of the end.

There are different **ways** in which international migrants can gain protection and/or rights. The **first** is the protection that exists for refugees under the terms of the 1951 Geneva Convention.	International **migrants** can gain protection and/or rights in different ways. The **first** is the protection that exists for refugees under the terms of the 1951 Geneva Convention.

Errors to avoid

Misplacing old and new information is a common error in scientific writing. The results are writing that lacks "flow", and readers who miss the main points. Several ways these errors occur:

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2) Writers **repeat old information at the end** of their sentences.
3) Writers **put the new information at the beginning** of an introductory sentence instead of the end.
4) Writers **add unnecessary words at the end of a sentence**; these words hide the new information.

During my elementary school years, **I** found that my most exciting and rewarding moments came from the sense of wonder I felt after learning something completely new to me for the first time. A second **wave** of amazement often arrived days or weeks later, when I actually began to understand what I thought I had learned.	During my elementary school years, **I** found that my most exciting and rewarding moments came from the sense of wonder I felt after learning something completely new. A second **wave** of amazement often arrived days or weeks later, when I actually began to understand it.

Strengthening sentences

The pooled effect sizes, both with and without adjustment for environmental risk factors, were larger for DNA-based than RNA-based viruses.	The pooled effect sizes were larger for DNA-based than RNA-based viruses, regardless of whether environmental risk factors were adjusted for.
It has been predicted that the global average temperature will increase at a rate of 0.2 degrees/decade.	Global average temperature has been predicted to increase at a rate of 0.2 degrees/decade.
In this study, taking advantage of a well-annotated genome map and effective targeted-mutagenesis techniques, we analyzed the role of Bac17 in pathogenesis by *Candida albicans*.	We analyzed the role of Bac17 in pathogenesis by *Candida albicans* by taking advantage of a well-annotated genome map and effective targeted-mutagenesis techniques.
The number of commercial products containing nanomaterials has risen rapidly; in 2006 there were only 212 while in 2009 there were over 1000 products on the market.	The number of commercial products containing nanomaterials has risen rapidly; in 2006 there were only 212 while in 2009 there were over 1000.
The data did not support our initial hypothesis, as no clear trend in reaction rate with pH was observed.	The data did not support our initial hypothesis, as there was no clear trend in reaction rate with pH.
The qualitative agreement between caribou's preference for feeding on young leaves and the trend for protein to decline with leaf age supports the hypothesis that caribou migration is driven by the patterns of leaf-out and maturation spatially and temporally through their home range, rather than by weather.	Caribou prefer to feed on young, protein-rich leaves, supporting the hypothesis that migration is not driven by weather but by the spatial and temporal patterns of leaf-out and maturation.

How to write based on readers' expectations

1) Establish importance: what do you want to emphasize? Try to ensure that the relative emphasis of the substance coincides with the relative expectations for emphasis raised by the structure.

2) Old information at the beginning in the topic position (context and backward linkage).

3) New information that you want to emphasize at the end in the stress position.

4) Provide context for your reader before asking them to consider anything new.

5) Get to the subject of the main sentence quickly, and make it short and specific. If possible, use central characters and avoid topics as subjects.

6) Avoid interruptions between the subject and verb (and between the verb and object).

In real and important ways, the structure of the prose becomes the structure of the scientific argument. Improving either one will improve the other.