Notes on the Writing of Scientific English for Japanese Physicists

- Professor Anthony J. Leggett - (2003년 노벨 물리학상 수상자)

※ 이 글의 원문의 저자(A. J. Leggett)는 일본식 영어에서 빈번하게 발생하는 문제들을 고쳐주기 위해 이 글을 썼습니다. 일본어와 한국어가 비슷한 언어 체계를 가지고 있기 때문에 제가 느끼기엔 저자가 지적한 문제들이 한국식 영어에도 빈번하게 드러난다고 보입니다. 따라서 아래 번역에 '일본인', '일본식 영어'와 같은 표현들은 한국인, 한국영어(콩글리쉬)라고 치환해서 읽으시길 바랍니다. 또한 영문 번역의 특성상 의역이 많아서 누락된 내용이 있을 수 있을 뿐만 아니라 번역본에서는 원저자의 뉘앙스를 다 담지 못했습니다. 개인적으로는 영어원문을 읽다가 이해가 안가는 부분이 있으면 번역을 보시는 것을 추천하며, 아니면 한글판을 메인으로 읽다가 이해 안가는 부분을 영문판을 참고하셔도 됩니다. -2018.12. 김용완-

※ 본문의 '나'는 원문의 저자인 A. J. Leggett를 지칭합니다. 그리고 '원어민'은 영어에 대한 원어민을 지칭합니다.

Introduction

이 글에서는 과학 글쓰기위한 종합적인 가이드를 위해 작성된 것이 아니다. 그와 관련된 가이드북이라면 시중에 굉장히 많이 있으니 참고하길 바란다. 오랜세월 'Progress' 저널에 투고된 논문을 검수하다가 일본식 영어에서 발생하는 실수가 일정한 패턴을 가지고 있다는 것을 발견하였다. 그리고 대부분의 것들은 단순한 규칙만 알고 있으면 피할 수 있는 실수였다. 그렇기때문에 이 글은 일본식 영어를 읽기 힘들게 만드는 공통적인 실수들과 에러들을 제거하기 위한 방법을 중점적으로 다루었다.

이 글의 메인 가이드를 요약하면 다음과 같다.

첫 째로, 영문 글을 작성을 할 때 영어를 우아하게(elegant) 만드는 것보다 명료하게 쓰는 것이 무조건 중요하다. 그렇기 때문에 우아한 표현이지만 잘 이해가 안가는 문장과 투박하지만 명료한 표현 중 선택을 해야 하면 무조건 후자를 선택하길 바란다.

둘 째로, 실수를 피하는 것은 글을 읽는 독자의 피로도를 줄여주고 독자들이 글을 이해하기 위해 써야하는 신경이 줄어든다는 점에서 매우 중요하다. 그래서 논문을 쓸 때 관사(a, the)나 전치사와 같은 미시적인 부분보다는 문장의 구조 등과 같은 거시적인 부분을 개선하기위해 더 많은 시간을 할애하는 것을 추천한다. 미시적인 부분의 실수는 독자들이 글을 이해하는 데 큰 방해가 되지 않으며 쉽게 고치며 글을 읽어나갈 수 있다. 하지만 거시적인 부분이 혼란스럽게 적혀있으면 독자들이 내용을 파악하는데 한계가 있을 뿐더라 글을 이해해내기 위해 많은 노력을 쏟아야해서 피로도가 급격하게 높아진다. (그런 글은 아무도 끝까지 읽고 싶어하지 않을 것이다.)

셋 째로, (지금 내가 쓰고 있는) 이글과 같은 가이드들이 (실수를 피하기 위한) 규칙을 복잡

하게 써놓을 수록 쓸모가 없어진다. 즉, 모든 실수를 완벽하게 고치기위해 모든 규칙을 다 설명하고 그것을 익히려고 하는 것보다, 간단한 규칙으로 고칠 수 있는 95%를 설명하고 그것을 완벽하게 익히는 것이 중요하다. 그리고 사실 남음 5%는 지키지 않는다고 심각한 문제를 초래하지 않는다. 그래서 나는 이 가이드를 읽은 독자가 실수없는 아름답고 완벽한 글을 써내려가길 바라지 않는다. 단지, 이 가이드에 나온 규칙을 따라 글을 명확하고 읽기 쉽게 쓰기를 바라고, 혼동을 주는 심각한 실수만 안하기를 바랄뿐이다.

이 가이드는 '거시적인' 설명을 시작으로 '미시적인' 규칙들까지 설명할 것이다. 가이드의 초반 (거시) 파트는 (큰틀에서의 설명이라) 설명들이 다소 일반적이면서 추상적으로 들릴 수 있겠지만 근본적으로 매우 중요하다. 가이드의 후반 (미시) 파트는 매우 구체적이고 정확한 설명을 예시를 들어 설명할 것이다.
이 가이드에서 "A→B"라는 표시는 A는 틀린 문장이고 B는 그걸 고친 맞는 문장임을 의미한다. 그리고 (X)표시는 틀린 문장 혹은 잘 안쓰이는 어색한 문장이고, (O)표시는 올바른 문장 또는 좋은 표현이다. 여기에 나온 문장 예시들은 내가 설명을 위해 만든 문장도 있고 실제 논문에서 쓰인 표현을 설명을 위해 조금 바꿔서 가져온 것이다. 그러니 혹여 예시문이 물리적으로 틀렸더라도 그런 것은 여기서 중요한게 아니니 신경쓰지 말자.

I. General

보통 사람들은 일본어를 영어로 훌륭하게 번역할 수만 있다면 영어로 글을 쓰는 것에 전혀가 문제가 없을 것이라고 생각한다. 이는 절대 틀린 얘기다. 적어도 일본식 영어는 문법적으로 완벽하다. 하지만 일본식 영어로 쓰인 글은 원어민 독자에게는 굉장히 불분명하고 난해하게 느껴진다. 이것은 단순한 번역의 문제가 아니다. 원문이 일본어였던 글을 전문 번역가가 번역을 하더라도 비슷한 현상이 종종 나타난다.

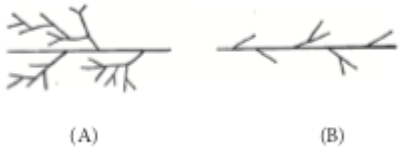
이러한 현상의 가장 근본적인 이유는 사고 패턴의 차이이다. 일본인들의 사고 패턴을 그대로 영어로 풀어내었을 때 그것이 원어민에게는 난해하게 읽힐 가능성이 크다. (영어를 일어로 번역할 때도 비슷한 일이 발생한다.) 예를 들어, 많은 일본인들은 논문에 자신의 주장 혹은 결론을 얘기할 때 불분명하게 기술하거나 모호하게 말하려는 습관이 있다. 관습상 일본 사람들은 직설적인 화법을 사용하는 것을 싫어하기 때문이다. 하지만 원어민들은 이렇게 불분명하고 모호하게 쓰여진 글을 읽으면 저자가 자신의 주장에 확신을 가지고 있지 않다고 단순하게 생각해버린다.

다음은 내가 생각하는 일어와 영어의 차이점이다.

1. 글의 병렬 구성

보통 글 안에는 많은 생각들을 병렬로 들어가있다. 그리고 이러한 글의 구성에서 그 생각들을 유기적으로 풀어내고 연결하는 것이 매우 중요하다.

ⓐ **병렬 문단간의 유기성** - 일본인들은 글을 구성할 때 독자가 논문 전체 혹은 단락 전체를 읽고 나서야 글에서 말하고자하는 주장들과 그 주장들의 유기성을 파악할 수 있도록 글을 구성한다. 예를 들어, 글에 순서대로 A B C D 내용이 병렬로 쓰여있다면 일본식 영어는 C를 읽어야 B를 이해할 수 있다. 하지만 이러한 글 구성은 원어민들에게는 매우 어색한 글 구성이다. 원어민들은 정말 단순하게도 글을 구성한다. 글 안의 모든 문장이 그 문장의 이전에 쓰여져 있는 내용만으로도 완벽하게 이해되어야한다. 즉, 원어민이 글이 A B C D 단락으로 구성되어 있으면 A만 읽으면 B를 이해할 수 있고, C는 A, B 안의 내용만으로도 이해할 수 있다.



ⓑ **큰 줄기 따라가기** - (글쓰기 일반론으로써) 글 속에서 하나의 생각과 그 다음 생각 간의 관계가 명확하게 드러나야 한다. 예를 들어서 맥락을 구성하는 큰 줄기의 내용이 있고 그 줄기에서 벗어나는 내용을 서술해야할 때는 **반드시 그 단락 혹은 문장의 시작에서 약간 줄기에서 벗어난다는 것을 명확하게 명시** 해줘야한다. 그림의 (A)처럼 메인 줄기에서 너무 가지치기가 많은 글은 절대 좋은 글이 아니다. (B)처럼 메인 줄기를 따라가면서 적은 가지가 쏟아있는 글이 좋은 글이다. 만약 기나긴 부연 설명(가지)이 필요하다면 풋노트(footnote)를 쓰는 것을 추천한다.

2. 글의 직렬구성

ⓐ **행간에 공백없도록!** - 글을 직렬로 구성할 때 생각 혹은 문장의 시퀀스가 명확해야한다. 일본인들은 글의 직렬 구성에서 행간을 채우는 것을 독자의 몫으로 남겨둔다. 그리고 독자가 생각을 해서 그 행간을 채우기를 바란다. 하지만 영문에서는 행간이 있는 순간 독자들은 글을 이해 못하기 시작한다. 예를 들어,

"It is uncertain whether **this resonance** should be assigned to the (56) or (82) representation, though Jones has suggested that **its spin is 1/2**."

(직역 : "이 resonance가 (56)에 배치되어야하는지 (82)의 representation에 배치되어야하는지가 불분명하다. 비록 존이 스핀이 1/2라고 제안하고 있기는 하지만.")

이 문장은 'though'를 기준으로 앞에 공백이 있다. 'resonance가 (56)과 (82) 중 어디에 배치되어야하는 지'와 '스핀이 1/2인 것'과 무슨 관련이 있는지가 불분명하다. 이 문장은 아래와 같이 고쳐써서 행간의 공백을 채워줘야한다.

"It is uncertain whether this resonance should be assigned to the (56) or (82) representation, though Jones has suggested that its spin is 1/2, **which, if true, would force us to assign it to the (56) representation.**"

("스핀이 1/2이라는 것이 사실이라면 그 것은 resonance를 (56)에 배치되어야한다.")

부연 설명을 통해 앞서 발생했던 행간의 공백을 채워주었다.

ⓑ **글이 길어져도 명확하게!**

상당히 많은 저자들이 이와 같이 자세하게 부연설명 하는 것을 문장이 길어지는 것을 염려하여서 피하려고 한다. 그리고 (특히 논문은 높은 지식을 가진 독자만 읽을 것이니) 독자가 그 행간의 공백을 충분히 채울 수 있다고 생각한다. 하지만 (일본어 글은 어떨지 모르겠지만) 적어도 **영문 글에서는 차라리 글이 길어지더라도 공백없이 명확한 것이 글이 짧고 불분명한 것보다 훨씬 좋다.**

3. it /which/ this : 명확한 지칭 대상 필!

영어의 문장은 정확하고 확실해야한다. 글을 쓰고 "이 문장이 의미하는 바가 정확히 무엇일까?"라는 물음에 스스로 답하지 못한다면 그 문장은 버려야한다.
예를 들어, it / which / this 등을 쓸 때 "내가 쓴 it/which/this이 무엇을 지칭하지?"라고 항상 물어야한다. 영어에서 it이란 항상 정확한 대상을 지칭할 때 사용하며 그것은 앞에 나온 내용에서 나왔어야한다. (물론, 가주어로 사용하는 it의 경우는 제외.). 내 마음속에만 있는 무언가를 지칭하기 위해서 it/which/this 등을 사용하지 말자.
참고로 좀 복잡한 경우들이 있기는 하다. 예를 들어 the fact that의 경우에 fact가 지칭하는 것이 앞선 내용에 나올 필요가 없다.(이때 the fact는 that 이하를 지칭하는 것.)

4. 직설적인 표현을 써라.

ⓐ 직설적으로 의견을 개진해라. - 일본인들은 직설적인 문장을 쓰는 것이 독자에게 자신의 주장을 강요하는 주제 넘는 행동이라고 생각한다. 그래서 생각의 다양성과 다른 가능성을 존중해주기 위해서 이를 피하려고 하는 경향이 있다. 하지만 이런 것은 원어민들에게는 친숙하지 않다. 만약에 저자가 해석의 다양성을 위해서 저자의 의견을 배제하고 **문맥적 공란을 남겨놓는다면, 원어민들은 단순하게 저자 자신의 의견 및 결론에 대해 정리를 못해서 갈피를 못잡고 있다고 생각**한다. 그러므로 저자는 혹여 자신의 결론이나 주장이 혹시 틀릴까 불안하거나 확신이 없더라도, (논문의 결론 및 주장으로써) 명확하고 확실하게 의견을 개진해야한다. 만약에 자신의 결론 및 주장에 대한 명확한 의구심이 존재한면 그것 또한 명확하고 구체적으로 적어주는 것이 좋다. (이때도 필요하다면 풋노트를 활용해라.) 그런 의구심이 있는게 아니라면 굳이 주장을 부드럽게 만드는 목적으로 직설적인 표현을 안 쓰는 것은 어리석은 행위이다.
ⓑ 추측성 표현은 번역하지 말라. - 일본인들은 추측성 표현을 많이 쓴다. "~~라고 생각하면 좋을 것 같다." "~~일 수도 있을 것 같다."등의 추측성의 어미나 표현들은 굳이 영어로 번역해서 쓰려하지마라. 이런 말들은 생략하고 나머지를 영어로 표현하면 (글이 자연스럽게 직설적으로 될 것이고) 더 좋은 문장이 될 것이다.

5. 중요하지 않는 문장은 노!

일본식 영어에는 중요하지 않은 의미를 담고 있는 절이나 문장이 많이 나타난다. 영어에서는 모든 절들이 각자 맡은 바에 대한 자기 몫을 반드시 해야 한다. 예를 들어,
"This may give a very **definite picture.**"
"This may be viewed from the standpoint(viewpoint) of **various considerations.**"
"It will be essential to study the problem from this point of view."
"This is useful not only for... but also for examination of the effect from **various sides.**"
위의 문장들이 뒤따라오는 설명 혹은 디스커션을 도입하는 목적으로 쓰여진 것이라면 적합하게 쓰인 것이다. (첫 번째 문장이후 정말 "definite picture"에 대한 서술로 넘어가야한다. 두

번째 문장 이후에는 정말 “various considerations”에 대한 열거로 넘어가야한다.) 하지만 이 뒤에 명확한 설명이나 디스커션 없이 단순히 ‘그냥 various considerations이 있다’ 등을 말하기 위한 용도로 단독으로 위의 문장들이 쓴 것이라면 매우 안 좋은 문장이다. 이런 문장은 안 쓰는 것이 글의 흐름상 좋다.
덧) 이러이러한 결과가 있다. 이는 여러 관점에서 **다양하게 해석**될 수 있다. (v) 그리고 이 수식은 …와 같은 수식으로 쓰일 수 있다. **(이 것은 안좋은 예시이다. (v)에 들어갈 말이 생략된 것이나 다름 없다. (v)에는 다양한 해석에는 무엇이 있는지 서술되어야한다.)**

“To summarise: make sure that your argument runs as a logical sequence and that no essential steps are left unwritten, be as precise, unambiguous and explicit as you can, and don't hesitate to state your conclusions boldly and definitely. Once this is done, the problem of writing good English is indeed largely reduced to the problem of good translation.”

II. Sentence Construction

앞 섹션에서 ‘명확한’ 글쓰기를 위한 일반론을 살펴봤다. 이번 섹션에서는 좀더 미시적으로 들어가서 명확한 글쓰기를 위한 문장 구성법에 대한 이야기를 해보겠다.

1. Write short sentences

명확한 표현을 구현하기 위해서는 문장을 짧게 쓸 필요가 있다. 사실 일본의 저널 Progress of Theoretical and Experimental Physics에 출간되는 논문의 평균 문장길이가 미국의 저널 Physical Review의 논문의 평균 문장길이보다 이미 짧다. 하지만 원어민이 아니라면 (사실 원어민이더라도) 문장이 길어지면 문장의 구성이 엉망이 될 가능성이 매우 커진다. 기본적으로 문장을 짧게 쓰면 쓸수록 말하고자하는 바를 명확하게 나타내는 것이 쉬워진다. 만약 영어 문장을 썼는데 40단어 이상을 넘었다면 이를 더 짧은 문장 여러 개로 쪼갤 수 있는지 고민해 봐야한다. 그것이 어렵다면 적어도 세미콜론(;)을 이용해보아라.(세미콜론의 용법은 뒤에 소개될 것이다.) 문장 길이로는 평균적으로 20단어 이하의 문장이 적당하다. 심지어 15단어로 이루어진 문장도 짧은 문장이 아니다. (하지만 앞 섹션에서도 말했지만 문장이 길어지는 대신에 뜻이 명확해질 수만 있다면 차라리 문장을 길게 써줘라.)
다음은 문장을 짧게 쓰기 위한 팁이다.

ⓐ **Strictly limited capacity** - 영어 문장은 “**Strictly limited capacity**”라는 것을 반드시 기억하길 바란다. 영어 문장에서 주절의 수식을 위해 붙는 종속절은 매우 적은 수만 허용된다. 그리고 그들은 모두 유기적인 문장 구조를 가지고 있어야 한다.
예를 들어, “Compared with the Nagoya model, these newer models seem to be rather more plausible in explaining the mechanism binding the baryons and leptons, **by introducing** a third quantum number besides the usual isotopic spin

and hypercharge and by considering the existing baryons and bosons to represent a neutral state of this quantum number, **although** they must generally produce many particles so far undiscovered, as a result of the increased number of elements and the reduced symmetry."

이 문장은 총 76단어로 이루어진 매우 긴 문장이다. 이 문장은 두 가지 문제점이 있다. 첫째로, 총 3파트의 말하고자 하는 바가 존재하는데 이를 저자가 하나의 문장 안에 다 담아내려고 하다보니 문장이 상당히 길어졌다. 둘째로, 주절과 종속절의 관계가 모호한 상태로 이어지고 있다. 위 문장에서 말하고자하는 바는 다음 3개이다.

(i) The newer models are better than the Nagoya model in explaining the binding mechanism.

(ii) The origin of this superiority is the introduction of a third quantum number, etc..

(iii) Nevertheless they predict many particles so far undiscovered.

이제 (i)~(iii) 간의 관계를 명확하게 하여 다시 문장을 구성해주면 아래와 같다.

"Compared with the Nagoya model, these newer models seem to be rather more plausible in explaining the mechanism binding the baryons and leptons. **This is because they** introduce a third quantum number besides the usual isotopic spin and hypercharge, and **they** consider the existing baryons and bosons to represent a neutral state of this quantum number. **However,** they must generally produce many particles so far undiscovered, as a result of the increased number of elements and the reduced symmetry."

원래의 글보다 좀 더 명료한 글이 되었다.

또 다른 예이다.

"From eq. (3.10) we get the final result that the inelastic shadow scattering must dominate the cross-section above a few tens of BeV, if we assume SU(6) symmetry and take the parameter λ to have a reasonably small value, **which** is in strong disagreement with the experimental results unless we assume a very peculiar form for the function f(S), as was shown by Brown from considerations of crossing symmetry."

이 문장도 매우 길다. 여기도 두 가지의 문제점이 있다. 첫째로, which 앞의 결과가 실험의 결과랑 잘 맞지 않다는 것은 매우 중요한 포인트이다. 그런데 '**which** is in strong disagreement with the experimental results'가 종속절로 빠지면서 묻혀버렸다. 둘째로, which가 지칭하는 바가 불분명하다. 이렇게 관계대명사가 지칭하는 바를 파악하기 어려우면 절 사이의 관계가 모호해질 수 밖에 없다. (which의 용법에 대해서는 섹션 III에서 더 자세히 다룬다.) 이제 문장을 쪼개서 중요한 포인트를 강조하고, 불분명한 절 사이의 관계를 분명하게 만들어보면 아래와 같다.

"From eq. (3.10) we get the final result that the inelastic shadow scattering must dominate the cross-section above a few tens of BeV, if we assume SU(6) symmetry and take the parameter λ to have a reasonably small value. **This result** is in strong disagreement with the experimental results unless we assume a very

peculiar form for the function f(S), as was shown by Brown from considerations of crossing symmetry."
단순히 문장만 끊었는데 두 가지 문제점이 다 해결되었다.

ⓑ "as", "similarly to", "by(in) ...ing" - 문장의 끝에 추가적인 구나 절을 붙일 때는 과연 추가적인 문장이 지칭하는 바 혹은 말하고자 하는 바가 명확한지를 확인해보아라. 특히, "as", "similarly to", "by(in) ...ing"를 붙일 때 이러한 문제가 많이 발생한다.
예를 들어,
"We find that the function F(x) has an infinite range but the magnetisation below T_c does not tend to a finite value, **as was suggested by Brown.**"
이 문장에서 Brown이 주장한 바("as was suggested by Brown")는 아래와 같이 세 가지로 읽힐 수 있다. 따라서 (저자는 의도에 따라) 문장을 쪼개어서 "as was suggested by Brown"가 말하고자 하는 의도를 명확하게 명시해주어야한다.
(i) We find that the function F(x) has an infinite range but the magnetisation below T_c does not tend to a finite value, as was suggested by Brown.
(우리(We)가 찾아 낸 것이 "the function F(x) has an infinite range but the magnetisation below T_c does not tend to a finite value"이라면 이를 Brown도 제안했었을 것이다.)
=> 이 경우 다음과 같이 고쳐주면 명확하다. "We find that the function F(x) has an infinite range but the magnetisation below T_c does not tend to a finite value. **These results agree with the suggestion of Brown.**"
(ii) We find that the function F(x) has an infinite range but the magnetisation below T_c does not tend to a finite value, as was suggested by Brown.
(우리(We)가 찾아 낸 것이 "the function F(x) has an infinite range"이고 '하지만' "the magnetisation below T_c does not tend to a finite value" 이고, 이 두 번째 것을 Brown이 주장한 것일 수도 있다.)
=> 이 경우 다음과 같이 고쳐주면 명확하다. "We find that the function F(x) has an infinite range but the magnetisation below T_c does not tend to a finite value. **This second result agrees with the suggestion of Brown.**"
(iii) We find that the function F(x) has an infinite range but the magnetisation below T_c does not tend to a finite value, as was suggested by Brown.
(우리(We)가 찾아 낸 것이 "the function F(x) has an infinite range but the magnetisation below T_c does not tend to a finite value"이고 "as was suggested by Brown."의 바로 앞에 있는 "finite value"라는 주장을 Brown했었을 수도 있다. 즉, Brown이 "the magnetisation below T_c tends to a finite value."를 주장한 것이다.)
=> 이 경우 다음과 같이 고쳐주면 명확하다. "We find that the function F(x) has an infinite range but the magnetisation below T_c does not tend to a finite value. **This second result conflicts with the suggestion of Brown.**"

또 다른 예시이다.
“This feature seems to be disadvantageous to the collective nature of the excitation ….. especially **in bringing about a large transition probability.**”
(“This feature”가 large transition probability를 bring about하는 지 안하는지가 모호하다. 이는 문장을 끊어주고 모호한 부분을 명확하게 만들어주어야한다.)
=> “This feature seems to be disadvantageous to the collective nature of the excitation ….. **In particular, it (cannot) bring about a large transition probability.**”

cf) on ~ing : ~ing 할 때/하자마자, in ~ing : ~ing 할 때/ 하는데 (있어서), by ~ing : ~ing 함으로써

“In short, whenever you are tempted to write a subsidiary clause after the main one, ask yourself whether it wouldn't be better to start a new sentence. This may sometimes be the less elegant alternative but, provided it is grammatically possible, it is rarely wrong and the gain in intelligibility usually amply compensates for the loss in elegance!”

2. Use of the semi-colon(;)

세미콜론(;)은 긴 문장에서 절과 절 사이에 유기성이 높아서 두 개로 쪼개기가 힘든 데 쪼개야하는 경우에 사용되곤 한다. 즉, 콤마(,)를 쓰기에는 두 개로 쪼개는게 좋을 것 같고, 온점(.)을 쓰기에는 둘을 연결해서 써야할 때는 세미콜론(;)을 쓰면 된다. (그래서 온점과 콤마를 합친 형태인가 보다.) 하지만 문법적으로는 완전 문장을 끊는 것과 같다. 그래서 세미콜론 뒤에는 주어+동사(+목적어)를 갖춘 완전한 문장으로 써야한다.
예를 들어, 아래 문장을 두 개로 쪼개는 경우를 생각해보자.
"High energy scattering above a few GeV is investigated as the shadow scattering of multiple production, **for which** phenomenological, peripheral and uncorrelated jet models are used."
이 문장을 두 문장으로 쪼개기에는 앞 뒤 문장이 “for which”로 연결되어 유기적이다. 또한 쪼개버리면 각 문장들이 너무 짧아서 ‘jerky effect’(‘글을 읽는데 문장이 짧아서 자꾸 급정지 급출발하는 느낌이 드는 효과’로 생각됨.)가 발생한다. 딱 이런 경우에 세미콜론을 쓰면 된다.
"High energy scattering above a few GeV is investigated as the shadow scattering of multiple production; phenomenological, peripheral and uncorrelated jet models are used."

또 다른 예시를 보자.
"We investigate the scattering of pions by protons at a few MeV, **paying** special attention to the problem of the imaginary part of the phase shifts, **which** was previously discussed by Jones, **who** assumed a hard-sphere potential, in the SU3

model."
이 문장은 주절에 추가적인 문장이 너무 덕지덕지 많이 붙어있다. 물론 다 필요한 설명이다. 이렇게 말이 길어지면 모호한 부분이 발생한다. 예를 들어, “in the SU3 model”가 “We investigate ... in the SU3 model.”로 읽힐 수도, “....discussed by Jones,..., in the SU3 model."로 읽힐 수도 있다. 이때, 세미콜론으로 적절하게 중간을 끊어주면 문장도 깔끔해지고 의미도 명확해진다. (저자의 의도가 후자라고 가정했다.)
"We investigate the scattering of pions by protons at a few MeV, paying special attention to the problem of the imaginary part of the phase shifts; **this** was previously discussed by Jones, who assumed a hard-sphere potential, in the SU3 model."

글을 쓰다가 주절에 “...., which ....” 또는 “..., and it ....” 등을 붙이고 싶을 때는 세미콜론을 써서 “....; this (result) ....” 등등으로 바꾸어보아라. 뒤에 추가 절을 붙이고 싶은 경우 대부분은 아예 새로운 문장을 시작하거나 세미콜론을 사용하면 훨씬 명료하고 깔끔한 문장이 완성된다. 여기서 주의해야할 점은 하나의 문장에 세미콜론을 두 번쓰는 경우는 (거의) 없다. 하지만 세미콜론을 충분히 사용여서 문장을 짧게 분리한다면 문장이 보다 훨씬 세련되질 것이고, jerky effect도 발생하지 않을 것이다.

3. Keep qualifying phrases and clauses to what they qualify

수식하는 표현(구 또는 절)을 쓸 때 그것이 무엇을 수식하는 지 명확하게 만들어야한다.

ⓐ 앞서 보았던 예시를 먼저 봐보자.
"We **investigate** the scattering of pions by protons at a few MeV, paying special attention to the problem of the imaginary part of the phase shifts, which was previously **discussed** by Jones, who assumed a hard-sphere potential, in the SU3 model."
여기서 “in the SU3 model”이 수식하는 것이 “discussed by Jones .... in the SU3 model”인지 “We investigate .... in the SU3 model.”인지가 모호하다. 이를 명료하게 하기 위해서는 의도에 따라 아래와 같이 바꾼다.
"We **investigate, in the SU3 model,** the scattering of pions by protons at a few MeV, paying special attention to the problem of the imaginary part of the phase shifts, which was previously discussed by Jones, who assumed a hard-sphere potential."
또는
"We investigate the scattering of pions by protons at a few MeV, paying special attention to the problem of the imaginary part of the phase shifts, which was previously **discussed in the SU3 model** by Jones who assumed a hard-sphere potential."
여기서 “in the SU3 model”의 위치를 수식하고자하는 동사의 뒷편으로 옮겨줌으로써 모호함

이 사라졌다.

또 다른 비슷한 예시이다.
"The theory can **explain** the magnetic moments of the baryons, the approximate SU(6) symmetry scheme satisfied by all low-lying resonances and the fact that the scattering amplitudes appear to be well **predicted** by the Smith formula **in a unified way.**"
이 문장에서는 "in a unified way"가 "explain"을 수식하는지 "predicted"를 수식하는지 모호하다. 이 또한 의도에 따라서 아래와 같이 수정되어야한다.
"The theory can **explain, in a unified way,** the magnetic moments of the baryons, the approximate SU(6) symmetry scheme satisfied by all low-lying resonances and the fact that the scattering amplitudes appear to be well predicted by the Smith formula."
또는
"The theory can explain the magnetic moments of the baryons, the approximate SU(6) symmetry scheme satisfied by all low-lying resonances and the fact that the scattering amplitudes appear to be well **predicted in a unified way** by the Smith formula."
이처럼 수식하고자 하는 표현 바로 뒤에 수식용 구 또는 절을 위치시키면 수식에대한 모호함은 간단하게 해결된다.

ⓑ 한 번에 하나 이상의 수식용 구나 절을 사용하여 하나의 단어를 수식하는 것은 웬만하면 피하는 것이 좋다. 하지만 **반드시 하나 이상을 써야한다면 짧고 중요하지 않은 순서로 수식어를 붙여줘라.**
예를 들어,
"We can **carry out the integration** by making the substitution $x=y^2$ and transforming to polar coordinates in a straightforward way"
위의 문장에서 "carry out the integration"을 수식하는 표현이 'by making ...'과 'in a straightforward way'로 두 개가 있다. 이 때 위와 같이 쓰는 것 보다 더 짧고 중요하지 않은 표현인 "in a straightforward way"을 먼저 쓰면 아래와 같이 더 명료한 문장이 된다.
"We can carry out the integration **in a straightforward way** by making the substitution $x=y^2$ and transforming to polar coordinates."
수식용 구들의 순서만 바꿨는데 문장이 더 명료하게 다가오는 것이 느껴질 것이다.

ⓒ 수식용 구(절)를 붙일 때 무엇보다도 주의해야할 사항이 있다. 수식의 대상이 반드시 수식하고 있는 문장 내에 있어야한다. (당연한 말 같지만, 생각보다 영어 작문을 할 때 사람들이 많이 범하는 실수이다.)
예를 들어,
"The proton and neutron masses are different **by considering the effect of the pion cloud.**"
이 문장에는 "by considering ..."이 수식해주는 말이 없다. ("누가 무엇을 consider한다."에

서 '누가'가 빠져있다.) 그래서 아래와 같이 "We"를 추가해주어야한다.
"**We can understand (explain)** the fact that the proton and neutron masses are different **by considering the effect of the pion cloud.**"
또는 "We"라는 주어가 필요한 "by considering"이란 표현을 제거하고 아래와 같이 고쳐도 된다.
"The proton and neutron masses are different **because of** the effect of the pion cloud."

"In short: remember that in English every subsidiary clause and phrase must have a definite place in the sentence structure, and that as far as possible this place should be clearly indicated by the sentence order. Don't hang subsidiary clauses on to the end of a sentence if you are not sure just where they fit in - start a new sentence instead."

III. Relative Clauses (.."which....", "who....", etc.)

1. 영문에서 관계사는 두 가지의 용도로 사용된다.

첫 번째 용도는 주절의 주제에 대해서 추가적인 사실을 언급(state)하거나 묘사(describe)하기 위한 용도이다. 이 경우에는 관계사(which) 앞에 컴마(,)를 삽입해주어야 한다. 두 번째 용도는 주절 안에있는 표현(명사 등)을 identify하기 위한 경우이다. 이 경우에는 관계사 앞에 컴마를 쓰지 않는다.
즉, 관계사 앞에 컴마의 유무에 따라 문장의 해석이 완전하게 달라진다.
예를 들어
(i) "We find the solution of eqs. (8-10) **which remains finite as x→0.**"
(우리는 x→0일때 유한해지는 솔루션을 찾았다. (유한하지 않은 솔루션이 있을 수도 있다.))
=> 이 문장에서 "which remains finite as x→0."은 우리가 찾은 솔루션이 유한하다고 'identify'해주는 것이다. 더 나아가 유한하지 않은 솔루션의 존재 가능성을 암시한다. [원문 : Other solutions do not remain finite; it identifies the solution which we find.]

(ii) "We find the solution of eqs. (8-10), **which remains finite as x→0.**"

(우리는 (유니크) 솔루션을 찾았고, 그 솔루션은 x→0을 해도 유한하다.)
=> 이 문장에서 "which remains finite as x→0."은 컴마에서 한 템포 쉬고 뒤를 읽으면 된다. 관계사절은 우리가 유니크한 솔루션을 찾았고 그것이 유한하다는 부연 설명을 해준다. ('유니크'한 솔루션이 아닌 경우 'the'를 'a'로 바꿔줘야 한다.) 참고로, 이 문장을 조금 더 명확하게 써주기 위해서는 아래와 같이 써주면 된다.
"We find the solution of eqs. (8-10); **this** remains finite as x→0."

2. ⓐ 일반적으로는 관계사의 **바로 앞에는** 수식하고자하는 명사가 반드시 있어야한다.

예를 들어,
"Some **solutions** were obtained by Jones **which satisfy eq. (3.9).**"
이 문장과 같은 형태는 반드시 피해야한다. which가 수식하고자하는 solutions이다. 하지만 which 앞에는 Jones이 존재한다. 이는 "(3.9)식을 만족하는 Jone에 의해서 ...."로 의미가 받아들여진다. (역자생각: "Some **solutions which satisfy eq. (3.9)** were obtained by Jones."로 고치자.)
"The **pion** parity **which is emitted in the reaction**"
여기서, "**which is emitted in the reaction**"이 수식하고자 하는건 "pion"이다. 즉, 반응에서 내뿜어지는 것은 pion이지 parity가 아니다. (역자생각 : "parity of the **pion which is emitted in the reaction**"로 고치자.)

ⓑ 수식을 받는 명사가 반드시 관계사 앞에 나와야한다는 법칙에는 예외 상황이 있다. 그 명사가 다른 구나 다른 관계사에 의해서 이미 수식을 받고 있는 상황이다.
예를 들어,
"the **solution** of eqs. (8-10) **which** remains finite" [type (a)],
"the **solution** found by Smith, **which** remains finite" [type (b)].
이 두 경우에는 which가 eqs. (8-10) 또는 Smith를 수식하지 않고 solution을 수식한다. 이는 맥락적으로 파악하는 것이다.

하지만! 보통은 이렇게 수식하는 구 때문에 관계사 바로 앞에 수식하고자하는 명사가 바로 나오지 않는 경우에는 관계사가 무엇을 수식하려하는지 불분명한 경우가 대부분이다.
아래의 예를 보자.
"One then gets periodic solutions to the dynamical equations, **which** agree with those found by Jones."
=> 여기서 Jones이 찾은 것과 일치하는 것이 periodic solutions인지 the dynamical equations인지 모호하다. 이 때는 앞서 배운 세미콜론을 활용하면 된다.
"One then gets periodic solutions to the dynamical equations; **these equations** agree with those found by Jones."
또는
"One then gets periodic solutions to the dynamical equations; **these solutions** agree with those found by Jones."

"Let us consider **the** solutions of **the** equations **which** were found by Jones"
=> 이 예시 역시 Jones이 찾은 것이 solutions인지 equations인지 모호하다. 이때는 수식하려는 것이 무엇인지에 따라 다음과 같이 쓰면 된다.
"Let us consider **those** solutions of the equations **which** were found by Jones"
또는
"Let us consider the solutions of **those** equations **which** were found by Jones."
※ 수식하고자 하는 명사 앞의 "the"를 "that" 또는 "those"로 바꿔주면 "which"가 지칭하고자하는 바를 명확하게 만들 수 있다.

비슷한 예이다.
"We consider the irreducible subspaces of the space **to which P and Q belong.**"
"to which ..."가 밑줄친 두개 중 무엇을 수식하는지 모호하다. 아래와 같이 'the'를 'those' 또는 'that'으로 바꿔서 서로 간의 관계를 명확하게 만들 수 있다.
→ "We consider **those irreducible subspaces** of the space **to which** P and Q belong"
→ "We consider the irreducible subspaces of **that space to which** P and Q belong."

※ 관계사 'which'가 that 또는 those와 연결되어서 쓰이는 경우는 ***콤마 없이 관계사만 쓰는 타입****의 문장에서만 가능하다!*

3. 관계사 앞에 콤마가 나오는 경우에는 앞에 나온 명사가 아닌 문장 전체를 수식하는 경우가 종종 있다.
예를 들어,
"This argument predicts that the spin of U is 3/2, which is in contradiction with experiment."
이 경우, which는 "the prediction that the spin of U is 3/2"라는 전체 문장을 수식하고 있다.
하지만 이렇게 관계사가 문장 전체를 수식하는 문장 구성은 뜻이 모호해질 가능성이 매우 크다. 따라서 문법적으론 맞을지라도 피하는 것을 추천한다. 이런 문장 구성을 피하는 방법으로는 관계사에서 문장을 끊어서 새로운 문장을 '(앞 문장을 지칭하는) 명확한 명사'와 함께 시작하는 것이 있다. 예를 들어,
"This argument predicts that the spin of U is 3/2; **this prediction** is in contradiction with experiment."
세미콜론으로 문장을 두개로 쪼개주고, "this prediction"이 앞문장 전체를 지칭해줌으로써 문장이 훨씬 명료해졌다.

IV. "Any and All" especially in Negative and positive sentences

1. "Any" and "all" in negative sentences.

아래 두 경우((a)와 (b))는 다음과 같이 영어로 표현 할 수 있다.

(a) $\alpha 1 \neq 0$, $\alpha 2 \neq 0$, $\alpha 3 \neq 0$, $\alpha 4 \neq 0$
① "**All of** the α's are different from zero."
② "**None of** the α's are equal to zero."
③ "We have set **all of** the α's different from zero."
④ "We have set **none of** the α's equal to zero."
⑤ "We have **not** set **any** of the α's equal to zero."

(b) $\alpha1 \neq 0$, $\alpha2 \neq 0$, $\alpha3=0$, $\alpha4=0$
① "**Some of** the α's are different from zero."
② "**Not all of** the α's are equal to zero."
③ "We have set **some of** the α's different from zero."
④ "We have **not** set **all of** the α's equal to zero."

하지만
"**Any** of the α's are **not** equal to zero (X)" 또는 "**All** of the α's are **not** equal to zero (X)"와 같은 표현은 **쓸 수 없다.**
- "All ... are not (X)"과 같은 표현은 종종 쓰기는 하지만 **잘 알려진 표현은 아니니** 피하는 게 좋다.
- "any" 뒤에는 "not"과 같은 부정적인 표현을 쓸 수 없다. (not 뒤에는 any가 나와도 된다.(ex) (a)⑤)
- 만약에 "**Any** mesons are **not stable.** (X)"과 같은 표현을 쓰고 싶다면 "**No** mesons are **stable** (O)"(앞 문장이 "All mesons are unstable."을 의도한 경우.)이나 "**Not all** mesons are **stable** (O)"(앞 문장이 "Some mesons are unstable."을 의도한 경우.)

경험상 일본인이 "Any... are not..."과 같은 표현을 쓴 경우 많은 확률로 "None of the ... are ..."을 의도한 것 이였다.
예를 들어,
"**Any** problems ... do **not** occur." → "**No** problems ... occur."
"**Any**thing ... can**not** be done"
→ "**No**thing ... can be done." *or* "**We** can do **no**thing" *or* "**We** can**not** do **any**thing"
"**Any**one has **not** proved" → "**No**-one has proved."

덧1) "This series does **not ever** converge (X)"이란 표현은 잘못된 표현은 아니지만, "This series **never** converges (O)"가 더 자연스러운 표현이다. (ever은 any처럼 not 뒤에 쓸 수 있긴하다.)
덧2) '덧1)'의 관점에서 보면 "not.... any"와 같은 표현을 "none" 또는 "no"로 바꾸면 더 자연스러운 문장으로 만들 수 있다. 그래서 (a)④의 표현이 (a)⑤의 표현보다 더 나은 표현이다.

2. "Any" and "all" in positive sentences.

ⓐ 아래 두 문장은 비슷하지만 완전 같은 뜻을 가진 문장이 아니다.
* "All higher-order terms may be neglected"
(higher-order term들이 확실히 존재하고, 그들은 무시가능하다.)
* "Any higher-order terms may be neglected"
(higher-order term들이 존재할 수도 안 할 수도 있고, 만약 존재한다면 그들은 무시가능하다.)

ⓑ "Any"가 아래와 같이 관계사 앞에 붙는 것을 흔하게 볼 수 있다.
"**Any** interaction **which** breaks the symmetry will change the results"
이 경우, "any" 뒤에 따라오는 관계사 절 안에 부정적인 표현이 붙는 것은 허용이 된다.
예를 들어,
"**Any** interaction **which** does **not** conserve the symmetry will change the results."

V. "Only", "Mainly", "Not Only"

1. Only

ⓐ "only"는 다양한 위치에서 다양한 표현을 수식해 줄 수 있다. 하지만 "only"의 위치에 따라 그 문장이 말하고자 하는 바가 완전 달라진다.
예를 들어,
(i) "**Only** the spin-orbit interactions renormalise the lifetime."
(i.e. other interactions do not renormalise it).
(ii) "The spin-orbit interactions **only** renormalise the lifetime."
(i.e. they have no other effect).
(iii) "The spin-orbit interactions renormalise **only** the lifetime."
(i.e. they do not renormalise anything else).

앞에 본 것처럼 뜻이 완전히 달라지기 때문에 "only"는 수식하고자하는 단어 바로 직전 나와야한다.
또 다른 예로,
만약 "f(x,y) = $f(x,y)=x^2+y^2$, $g(x,y)=y^2$"라면, "**only** f is a function of x."라고 하면 된다.
반대로, 만약 "$f(x,y)=x^2$"라면, "f is a function **only** of x."라고 쓰면 된다.
덧) 이런 표현은 애매한 표현이니 피해야한다. "f is **only** a function of x." 또는 "f only is a function of x."

ⓑ 사실 앞선 문장들'(i),(ii),(iii)'은 아래와 같이 바꿔서 "only"가 수식하는 단어가 무엇인지 더 명료하게 만들 수 있다.
(i) "It is **only** the spin-orbit interactions which renormalise the lifetime."
(ii) "The **only** effect of the spin-orbit interactions is to renormalise the lifetime."
(iii) "The **only** thing renormalised by the spin-orbit interactions is the lifetime."

덧) 아래와 같은 경우도 주의하자.
"We have introduced **only one** free parameter" → "x is introduced as **the only** free parameter" (not "only one")
"The free parameters are **only** x and y." → "The **only** free parameters are x and y"

2. Mainly

비슷한 논리로 "mainly" (or "chiefly" "principally" etc.)에도 적용할 수 있다.
예를 들어, 문장 (ii)와 (iii)의 "only"는 “mainly”로 바꿔도 비슷한 의미가 유지가 된다.
하지만 문장 (i)은 문법적으로는 문제가 없지만 어떤 이유로 다소 이상한 표현이다. 그래서 원어민들은 이 문장에서 “only”를 “mainly”로 바꿔서 많이 사용한다. 즉, "It is **mainly** the spin-orbit interactions which...."라고 많이 쓴다.

3. Not only

ⓐ "Not only"는 "only"와 정말 같은 논리로 다루면 된다. 즉, 수식하고 싶은 단어 바로 앞에 쓰면 된다.
예를 들어,
"**Not only** x **but (also)** y is divergent."
"x is **not only** divergent **but (also)** meaningless."
"x **not only** diverges **but (also)** contains a factor T^{-1}."

ⓑ 만약 “not only”가 하나의 절을 수식해주고 싶다면 동사와 주어의 순서를 바꾸어줘야한다.
예를 들어,
"**Not only** *does* x diverge **but** x contains a factor T^{-1}."
(※“not only” 파트는 주어 동사 자리를 바꿔주는데, “but also” 뒤에는 안 바꾼다.)
덧) 만약 "Not only x diverges ...."라고 쓰면 “Not only”가 수식해주고자 하는 것이 무엇인지 굉장히 애매하다. 따라서 “Not only”가 뒤따라오는 절을 수식하겠다는 하나의 표식으로 ‘주어 동사 치환’을 해줬다고 이해하자.

VI. "May be" / "Can be" / "Is"

1. May be

ⓐ “May be”(추측)는 일어 표현인 “てあろう”(예의+추측)과 완전 똑같지 않다.
(てあろう : 번역하면 “~일 것 같습니다.” 직설적으로 말하는 것이 예의가 아닌 일본에서 사용하는 ‘예의+추측’의 의미가 담긴 표현.)
섹션I에서도 설명했지만 영어에서는 추측의 표현은 추측만을 의미할 뿐이다.
예를 들어, “f may be a function of x. (X)”라고 쓰면, 글쓴이는 y가 x의 함수인지 아닌지 잘 모른다는 뜻이다. [원문 :We don’t know whether y is a function of x or not.] 그냥 “y is a function of x. (O)”라고 쓰자. 만약 여기서 단지 “y is a function of x.”가 좀 직설적일 것 같아서 “may be”를 붙인 것이라면 원어민들은 혼란에 빠질 것이다.

다시 한번 말하지만, 영어에서 “may”를 붙인다고 문장이 더 예의바르게 만들어지지 않는다. 일본어나 한국어에서 볼 수 있는 예의바름(politeness)과 불분명함(vagueness)의 연결 관계는 영어에서는 볼 수 없다.

ⓑ **“May” 용법**은 다음 두 가지가 있다.
(i) 불확실함을 나타내는 경우.
ex) “This series may not converge.” / “The experimental data may be erroneous.”
(ii) 허용가능성(permissibility)를 나타내는 경우. (*이 경우 “may”는 “can”으로 치환이 가능하다.)*
ex) “We may approximate this term by ...” / “This term may not be neglected ...”
※ 이 두 가지 경우에 적합한 경우가 아니면 “may”를 절대 사용하지 말아야 한다.

ⓒ 만약 정말 てあろう과 같은 **예의를 위한 표현**을 찾는 다면 “We may say that ...”(may의 (ii)번 용법을 사용.)이라는 표현이 가장 적절할 것이다. 하지만 섹션 I에서도 강조했지만 영어에서는 돌려말하는 것 보다 직설적으로 쓰는 것이 가장 좋다.
덧) 그렇다고 앞서 보았단 예시인 “f may be a function of x (X)”을 “We may say that f is a function of x (X)”라고 고쳐쓰진 말자. y가 x의 함수인 것은 ‘의견’이 아닌 ‘사실’이기 때문이다.

ⓓ “It **may** be interesting/plausible/possible that ...(X)”은 틀린 표현은 아니지만, “may”를 “is”로 바꿔서 “It **is** interesting/plausible/possible that ... (O)”로 쓰는 것이 훨씬 (직설적이기 때문에) 더 좋은 표현이다.

2. “It is shown” vs “It can be shown”

ⓐ "It is shown (proved, demonstrated) ..... "은 *어떤 명확한 대상(수식, 이론 등)*이 ***불분명한 과거*에 증명이 되었거나, *아직 출간되지 않은* 논문에서 증명이 되었거나 한 경우**에 사용되는 표현이다.
(= A definite occasion, very rarely to the fact that something can be proved, has been proved at some indefinite time in the past, or has been proved by the author but not published.)
그래서 예를 들어,
"**It is (was, has been) shown** in ref.(6) that Z_3 is finite. (X)"은 ref.(6)이라는 명확한 곳에서 증명을 한 것이기 때문에 “It is (was, has been) shown”을 사용하는 것은 부적절하다.
"**It is shown** in the Appendix that Z_3 is finite. (X)"은 명확하게 Appendix에서 증명을 해놓았기 때문에 역시 “It is shown”을 사용하는 것은 부적절하다. 이런 경우에는 (“It is shown ..” →)**“It can be shown ...”**을 사용해야 한다. 즉, "**It can be shown** in ref.(6) (*or* in the Appendix) that Z_3 is finite *(but we shall not bother to do so here)* (O)".

ⓑ 또한 (같은 논리로) 증명이 바로 뒤따라오는 경우에도 “can be”를 사용하면 된다.

예를 들어,
"It **can be shown** as follows that Z_3 is finite:...." / "The cross-section **can be calculated** as follows : ...."

ⓒ **"is rewritten"과 "can be rewritten"**에도 같은 논리가 적용된다.
예를 들어,
"$f(x)$ **is rewritten** in the form.... (X)"라는 표현은 아주 틀린 표현이 아니고 종종 쓰이기는 하지만,
"$f(x)$ **can be rewritten** in the form.... (O)"이 더 적절한 표현이다.(hardly ever wrong.)
또는 "We rewrite $f(x)$ in the form ..."(여기는 "can" 안씀.)로 쓰는 것도 매우 좋다.
※ (역자생각) "$f(x)$ can be rewritten.."은 $f(x)$을 다시 쓴 주체가 명시 안 되어 있기 때문에 '할 수 있다'는 의미로 "can"을 붙이는 것 같고, ***"We rewrite.."는 확실한 주체(We)가 했다는 뜻이기 때문에 "can"을 안 쓰는 듯함.***

3. "It is thought (believed) that...."

"It is thought (believed) that...." 또는 "... is regarded as ..."와 같은 표현은 일반적으로 물리학자들에게 그렇게 '생각된다 (믿어진다)' 또는 '간주된다'는 의미를 내포하고 있다.

ⓐ "It is thought that...."
= "it is thought (believed) **by people (*or* physicists)** in general that...."
≠ "I think (*or* believe) that....".
즉, 나만의 생각이나 믿음이면 "It is thought that...."이라고 사용하면 안 된다.
예를 들어,
"it **is believed that** the nucleus consists of protons and neutrons."
이와 같이 "핵이 양성자와 중성자로 이루어져있다."는 일반적인 사실에는 "it is believed that"을 써도 된다. 하지만 "**The present author** believes that this result is in correct".
이와 같이 나만의 의견인 경우에는 "It is believed that this result is in correct. (X)"처럼 쓰면 안 된다.

ⓑ "V is regarded as an effective field"
= "It is regarded **by physicists in general** as ...."
≠ "I regard it as ..."
만약, 내가 "V가 effective field"임을 주장하는 것이면 "... is regarded as ..."가 아닌
"V **may be regarded as** an effective field" ("may"의 (ii)번 용법)로 표현하면 된다.

ⓒ 자주 쓰이는 표현 실수들.
* "is noted" → "is to be noted" or "may be noted" or "should be noted"
* "is desired (that)...." → "is to be desired" or "is desirable"
("it is desired to express y in terms of x" = "we wish to express....")

* "is emphasised"→ "is to be emphasised" or "should be emphasised"
* "is hoped" → "may be hoped" or "is to be hoped"
※ 여기서 주의할 점. 아래 두 문장은 구분해야한다.
 - "it **is hoped to investigate** this question" = "I **intend to investigate** it myself".
 - "it **is to be hoped** that this question will be investigated" = "I **hope someone else will** investigate it."

VII. Qualified Adjectives etc.

ⓐ 명사(*or* 구)를 수식하는 형용사(*or* 분사)의 위치
 만약 형용사나 분사로 명사(*or* 구)를 수식하고 있다면, 그들은 반드시 **명사(*or* 구)의 뒤에 위치**해야한다.
예를 들어,
 "**inverse** relation **of** eq. (7)" → "relation **inverse to** eq. (7)"
 "**exchanged** particles between them" → "particles **exchanged** between them"
 "**isobaric** state **of** the initial one" → "state **isobaric to** the initial one"
 "**identical** equations with (3.7)" → "equations **identical** with (to) (3.7)"
 "**relative** order of magnitude to" → "order of magnitude **relative** to"
 "an **intermediate** stage **of** the first two" → "a stage **intermediate between** the first two"

ⓑ 아래와 같은 경우도 주의하자.
 "**their intermediate** stage" → "the stage **intermediate between them**."
 "**its identical** equation" → "an equation **identical with it**".
 이처럼, *その*(그것의, 그들의)를 "its" 또는 "their"로 변역하기 전에 과연 위와 같은 실수를 하지 않았는지 다시 한번 생각해보자. **"Its", "their"**은 **"of it (them)"**로만 바꿔 쓸 수 있다. 하지만 이렇게 바꿔 쓰는 것도 *항상 성립하는 것은 아니다.*

ⓒ "of"가 형용사나 부사와 직접적으로 연결되어 있는 경우((ex) **"independent of ..."**)의 표현은 **"Its(their)"로 절대 치환될 수 없다.**
예를 들어,
 "the independent solutions **of the wave equation**"는 "**its** independent solutions"로 바꿀 수도 있고, 좀 어색하지만 "the independent solutions **of it**"으로도 쓸 수 있다.
하지만 "the solutions which are **independent of** x"은 **"its (i.e. x's)** independent solutions (X)"로는 **절대 바꿔 쓸 수 없고**, 반드시 "the solutions **independent of it (O)**"로 바꿔써야한다. *잘 모르겠는 경우엔 "of it (them)"을 쓰면 대부분 잘 맞다.*

ⓓ 또 다른 예로, 다음과 같은 표현에서도 실수가 자주 발생한다.
An even more misleading type of error is one like the following:

"This is a gauge-transformation invariant **of the electron operators**. (X)"
(여기서 "of the electron operators"은 "gauge-transformation"을 수식한다. 따라서 위와 같이 쓰면 안 되고 반드시 아래와 같이 써야한다.)
→ "This is an invariant with respect to gauge-transformation **of the electron operators**. (O)"
즉, 형용사와 분사 같은 수식어는 반드시 수식하고자 하는 표현 바로 뒤에 붙어야한다.

VIII. "A" vs "The" vs Nothing

ⓐ 사실 "A"와 "the"의 용법은 비원어민이 (심지어 원어민도) 가장 어려워하는 포인트이다. 하지만 관사를 잘 못쓴다고 글이 잘못 읽힐 위험성이 크지 않기 때문에 이 글에서는 관사에 대해 몇 가지 간단한 포인트만 담았다.
* "The"는 **유니크한 것**(the uniqueness of the object)을 말하고자 할 때 사용하면 된다.
* "a"(또는 복수)는 **유니크하지 않은 것**을 언급할 때 사용하면 된다.
예를 들어, 아래와 같이 "the"와 "a"는 미묘한 차이를 야기한다.
"**The** solution of (3.9) is given by (3.10)"
: 이 문장은 (3.10)에서 제시한 (3.9)의 해가 유니크하다는 것을 암시하고 있다.
"**A** solution of (3.9) is given by (3.10)"
: 이 문장은 (3.10)에서 제시한 해 이외에 다른 해가 있을 수 있음을 암시한다.

ⓑ 아래의 예시 쌍들을 통해 "a" (또는 "복수 표현")과 "the" 사이의 미묘한 차이들을 비교해 보자.

"f(x) is **an** analytic function of x."
"f(x) is **the** function of x defined by (3.11)."

"f(x) is **a** Bessel function."
"f(x) is **the** Airy function."
덧) 베셀 함수는 여러 가지가 존재하고 그중 하나가 Airy 함수이다.

(Assuming the system is 3 dim.)
"Two component**s** of the momentum commute with H."
"**The** three components of the momentum commute with H."

"Very small value**s** of t are unphysical."
"**The** very samll value**s** of t given by eq.(6) are unphysical."

"We regard x and y as quantiti**es** independent of R."

“We regard x and y as **the** only unknown quantit**ies** in this equation.”

ⓒ 사람들이 오해하는 부분이 있다. (컴마 없는) 관계사로 수식을 받을 경우 (마치 유니크한 무언가로 특정되어서 꼭 “the”를 붙여야 할 것 같지만) 반드시 “the”를 붙여야하는 건 아니다.
예를 들어,
“We must look for **the** metal which has **the** highest transition temperature.”
“We must look for **a** metal which has **a** high transition temperature.”

ⓓ *(역자 : 이 부분은 정확히 이해를 못해서 그냥 원문으로 남깁니다.)* "X theory" vs "The X theory". This is not an important point but a fairly definite rule can be given. If X is the subject-matter of the theory, then "X theory": e.g. "solid-state theory" "electromagnetic theory" "superconductivity theory". When X describes the postulates or methods of the theory, or names its author (s), then "the X theory": e.g. "the quark theory" "the BCS theory" "the quantum theory of radiation".
Thus, Professor Yukawa formulated "the meson theory [of nuclear forces]" but Schweber et al.'s book deals with "meson theory". Possibly in 1976 there will be "quark theory" but at present there is only "the quark theory"!

※ 하지만 영작을 할 때 더 중요하게 신경써야하는 포인트들이 너무 많기 때문에 “a”와 “the”를 올바르게 쓰기 위해서 너무 많은 걱정을 하지 않기를 바란다. (인트로덕션에서도 언급했지만 이런 마이너한 부분을 틀린다고 독자에게 혼란을 초래하는 경우는 드물다.)

IX. Singular vs Plural (단·복수)

ⓐ 아래의 단어들은 정말 웬만하면 단수로만 쓰인다. 가끔 복수로 쓰일 때도 있지만 그 경우에도 그냥 단수로 써도 무방하다.
“Nature, character, behaviour, notation, knowledge, information, (experimental) support, emission, scattering, advice, encouragement, agreement”
cf) “agreement” : 물리의 문맥에서는 단수로만 쓰인다.

ⓑ 일반적으로. **과정이나 행동(a process or action)을 묘사하는 단어들은 단수**로만 쓰이고는 한다. 하지만 ‘그 행동(action)에대한 **여러 가지 경우**’를 언급할 때는 복수로도 쓰인다.
"discussion"의 예를 보자.
"We give **a discussion** of this point in section 5"
: ‘디스커션을 할 것이다’는 행동에 대한 묘사이므로 복수(ex. "some discussions")가 아닌 단수인 “a discussion”으로 쓰인다. 하지만 아래와 같이 여러 개의 디스커션‘들’을 언급할 때는 복수로 쓴다.
"The **discussions** of this point given **in refs. (7) and (8)** are inadequate."
: 이 경우엔 명확하게 (7)번 참고문헌과 (8)번 참고문헌에서 언급된 디스커션이기 때문에 복수

로 썼다. 하지만, 만약 1개의 참고문헌에서의 디스커션을 언급한다면 아래와 같이 단수로 써야한다. "The **discussion** of this point given **in ref. (7)** is inadequate".

※ (사사에) 누군가들의 좋은 디스커션들에 감사한다는 내용을 쓸 때는 "helpful discussions"이란 표현을 쓴다.
예를 들어, ….. "thank one's colleag**ues** for **helpful discussions**."

ⓒ **"Situation"**이란 단어는 두 개 이상의 분명한 상황을 지칭할 때만 복수로 많이 쓰인다.
예를 들어,
"This **situation** is to be expected"
: 이 경우에는 여러 상황을 지칭하는게 아니기 때문에 복수(ex. "these situations")가 아니고 단수이다.
"There is a superficial resemblance **between our case and that studied by Smith**, but the **two situations** are really entirely different."
: 이 경우에는 "**our case** and **that** studied by Smith"에서 알 수 있듯이 우리 경우와 스미스의 경우 두 가지의 구체적인 상황을 지칭하고 있기 때문에 "situations"로 복수로 썼다.

ⓓ **"Experiment"**은 일반적으로 단수로 주로 쓰인다.
예를 들어, "in agreement with experiment"/ "according to experiment"/ "conflicts with experiment"/ "take the values of α from experiment".
하지만 구체적인 복수의 실험에 대한 언급은 복수로 쓴다.
예를 들어, "the experiments of Jones"/ "high-energy p-p scattering experiments".
cf) 복수로 쓸 때 주의할 점은 "experiments"와 "experimental data"를 명확하게 구분해야 한다. 예를 들어, "**the experiments** are subject to a large error.(X)"→"**the experimental *data*** are subject to a large error (O)".(실험 데이터에 큰 오류가 발생할 수 있습니다.)
(사실 한국말로는 '실험에 큰 오류가 발생할 수 있습니다.'와 '실험 데이터에..'와 비슷한 의미로 쓰이지만 영어에선 명확히 구분해서 쓰자.)

ⓔ 아래의 단어들은 **복수**로 주로 쓰인다.
"Features / properties / aspects / characteristics / circumstances"
예를 들어,
"Let us examine '**the properties/ some features / various aspects / the characteristics**' of this problem."
"In **these** circumstance**s**....",

하지만 '**하나의 특별한 그것(명사)**'(one particular property, etc...)을 지칭할 때는 단수로 쓰이기도 한다.
"The solution (2.8) has the peculiar(고유한, 독특한) '**property/feature/characteristic**' of being invariant under the interchange of x and y."
: **고유한** 특징이라고 명시를 해줬다.

"A disturbing **aspect** of this situation is that...."
: **구체적인** 측면이 that 이하에 나올 것이다.
"The unfortunate **circumstance** that f diverges makes it impossible to...."
: that 이하의 절이 circumstance을 하나의 **구체적인 것을 지칭하는 단어로 만들어줬다.**

한 가지 더 주의할 점은 보통은 "transformation **properties**" 또는 "symmetry **properties**"와 같이 쓰지만 "Hermitian **property**"와 같이 구체적인 Hermitian의 특징을 나타낼 때는 단수로 쓴다. [원문 : Notice in particular that one always says "transformation properties" "symmetry properties" but (usually), "Hermitian property" (this is the property of being Hermitian, whereas "transformation properties" does not simply mean the property of being transformed).]

X. Words to avoid or Use with care

ⓐ 과학 글에는 'the image of the Fermi surface'과 같이 테크니컬한 이유가 아니고서는 **"Image"**라는 표현은 절대 사용하지 않는다.
[원문 : "Image" is practically never used in scientific literature. (Except of course in a technical sense, as in 'the image of the Fermi surface')]

ⓑ **"Concrete"** : 우리는 보통 무언가를 설명을 할 때, '具体的(구체적)' 또는 '구체적으로'라는 표현을 상당히 많이 쓴다. 하지만 영어의 "Concrete"라는 표현은 그렇게 자주 쓰이지 않는다. 즉, 아래와 같은 표현은 안 쓰는 것이 좋다.
"a **concrete** example (X)"
"We chose a **concrete** form for the potential. (X)"
"This may give some very **concrete** images. (X)" : 특히 이 문장에서 "그것은 매우 구체적인 이미지를 제시한다."라는 표현을 위해서 'concrete image'를 사용한 것이라면 매우 안 좋은 번역이다. "concrete images"라는 표현을 아래와 같이 바꾸는 것이 자연스러운 표현이다. → "This may give a very **definite (clear) picture.** (O)".

ⓒ **"Standpoint"/ "viewpoint"** : 우리는 말을 할 때 "A라는 입장에서는 ....", "A 관점으로부터..."라는 표현을 많이 쓴다. 하지만 이를 "(X) from the standpoint(viewpoint) of ..."라는 표현으로 많이 영문 번역을 하는 것은 어색한 번역이다. 대신에 "(O) **in connection with** (the fact that....)" / "**in the light of** (the fact that)...."이 더 적절하다.

ⓓ **"aspect, character, nature, characteristics, features, circumstances, situation"**를 사용할 때 비원어민들은 부자연스럽게 사용하는 경우가 매우 많다. 이 표현들은 평소 영어 논문을 읽으면서 원어민들이 어떤 상황에서 사용하는지 잘 눈여겨보면서 자연스러운 문맥을 익혀놓으면 좋다. 또는 사전의 많은 예시들을 참고하길 바란다. 위의 단어들을 자연스럽게 사용한 예시들이다.
"This equation has a Markoffian **character**."

"The true **nature** of the forces binding the baryons is still not well understood."
"The true **nature** of the random-phase approximation is still not well understood."
"The solution (4.3) has a number of interesting **features**."
"The principal **characteristics** of the solution are as follows."
"Various **aspects** of this problem remain insufficiently explored."
"In view of the **circumstances** mentioned above, experimental detection may prove difficult."
"The **situation** here is entirely analogous to that encountered in p-p scattering."

※(역자 : 이해 못해서 원문 남김.) In certain cases two or three of these words may be interchangeable (cf. the example in section 9), but it is rash to assume that this is always so.

XI. Miscellaneous

ⓐ 사람들은 아래 표현들 간의 의미를 많이 헷갈려한다.
- "Ferromagnetism is usually **attributed to** the electron spins."(~을 ..결과(덕으)로 돌리다.)
- "The electron spins are usually **invoked to** explain ferromagnetism." (법,규칙등을 적용하다.)

- "The nucleus **consists of** protons and neutrons." (~가 ~로 구성되다.)
- "Protons and neutrons **constitute** the nucleus." (~가 ~을 구성하다.)

ⓑ $f(x,y)=f(x)$일 때, "f **is independent of** y. (O)"라고 쓰지, "The value of y **is irrelevant to** f. (X)"은 어색한 표현이다.
$f(x,y)=x^2 e^{-y^4}$일 때, "f **is sensitive to** the value of y. (O)"라고 쓰지, "The value of y **is critical for** f. (X)"은 어색한 표현이다.

ⓑ **"Necessarily does not...." vs "does not necessarily"**
- "does not necessarily" 예시 : "CPT invariance **does not necessarily** imply T invariance"
- "necessarily does not...." 예시 : "If the mass of the fission fragments is greater than that of the parent nucleus, then fission **necessarily does not** occur"
이때, 'necessarily does not occur'은 'cannot occur'의 의미로 쓰인 것 이다. 하지만 이 'necessarily does not'이란 표현은 **거의 쓰지 않는 표현**이기 때문에 웬만하면 안 쓰는 것을 추천한다.
※ *necessarily : 필연적으로*

ⓒ **"Both" vs "the two"**
- "both"의 예시 : "**Both** the renormalisation constants are equal to unity"

- “the two”의 예시 : "**the two** renormalisation constants cancel one another."
- 하지만 “서로가 서로 같다”는 의미로 사용할 때는 “both”가 아니라 “the two”를 써야한다.

ex) “**Both** renormalisation constants are equal (to one another)” → "**the two** renormalisation constants are equal".

ⓓ **“Quite” vs “considerably”**

이 두 단어는 “꽤, 상당히”라는 의미를 똑같이 가지고 있다. 하지만 뉘앙스 차이가 있다. “considerably”은 암시적으로든 표면적으로든 비교의 의미를 담고 있어야한다. 즉, ‘(....와 비교해서) 상당히 ... 하다’일 때 사용된다.

예를 들어,

“x is **considerably** larger than y”

“x is **considerably** reduced”

하지만 그렇지 않으면 “quite”를 쓴다.

예를 들어,

“x is **quite** large”.(‘무엇보다 크다’라는 비교가 없다.)

그런데 사실 "quite"는 아래 두 문장처럼 다소 모호한 뜻을 가지고 있다.

"The effect is **quite strongly suppressed**" = "suppressed to a large extent but not completely."

"The effect is **quite suppressed**" = "completely suppressed."

그래서 “quite”는 모호함을 피하고 싶으면 “rather”을 쓰면 된다.

ⓔ 아래 표현들은 **강도가 증가하는 순**으로 표현을 배열해둔 것이다.

“X is ‘**a little** larger < **somewhat** larger < **rather** larger < **considerably** larger < **a good deal** larger < **very much** larger’ than Y.”

“X is ‘**fairly** large ≒ **quite** large ≒ **rather** large < **very** large’.” (여기서 "fairly", "quite", "rather"으로 수식하는 강도는 거의 구분하기 어렵게 비슷하다.)

ⓕ **"Namely"(즉 + 단어) vs "that is"(즉, 부연하자면 + 문장)**

- **"Namely"**는 글쓴이가 이미 앞서 묘사했던 무언가를 지칭하거나 확인할 때 주로 쓰인다.

예를 들어,

“Using the best available data, **namely** these of Brown (=data)...”

“There is one difficulty. **Namely,** the integral in (3.1) does not converge (=one difficulty).”

- **"That is"**는 글쓴이가 앞서 언급했던 것에 대한 (부연) 설명을 위한 문장의 시작부에 사용된다.

예를 들어,

“Region II, **that is,** the region in which the heavy mesons play a dominant role....”

“The validity of this procedure is doubtful. **That is,** it is not clear that we can replace....”

※ 그런데 필자의 경험상, 문장이 시작할 때는 "Namely"와 "that is" 중 90%이상 "that is"가

쓰인다.

ⓖ 이 외에 여러 가지 자주 오용되는 표현들을 뽑아봤다.
"**will be able to** be replaced" → "**can** be replaced"
"**may have a possibility to**" → "**may be able to**" *or* "**can**"
"suggests **us** that" → "suggests that"
"The **concerned** baryon" → "The baryon **concerned**"
"**our interesting** amplitude" → "the amplitude **of interest to us**"
"We **pick up** the ring graphs"
→ "**pick out**"(선택하다. 뽑아내다.) / "**isolate**"(따로 떼어내다. 분리하다) / "**select ... for (special treatment)**"((special treatment)을 하기 위해 ...을 뽑다.)
"operating $\frac{\partial}{\partial x^{\mu}}$ on Ψ " → "operating **with** $\frac{\partial}{\partial x^{\mu}}$ on Ψ"
"**formulae (expressions) for** f " (***not*** "**of f** ")
"conditions (restrictions) **imposed on** M by rotational invariance" (***not*** "**to M**")
"**effect** of the Coulomb terms **on** S" (***not*** "**to S**")
"X can be **expressed (rewritten) in terms of** Y" (***not*** "**by Y**")
"**construct** the wave function **from** Bloch waves" (***not*** "**with**")
"X is **insensitive in comparison with** Y(X)" but "X is **less sensitive than** Y(O)"
"**associate** A **with** B" (***not*** "**to**")
$\sum_{p}$ = "a **summation over** p" (***not*** "**of p**")

XII. Minor Stylistic Points

ⓐ **"And" / "But" / "So"로 문장을 시작하지 마라.** (이건 구어체와 과학 문어체의 차이점이다.) 이 표현들 대신에 아래와 같은 표현을 쓰는 것을 추천한다.
"And" → "Moreover" / "Further"
"But" → "However" / "Nevertheless"
"So" → "Therefore" / "Hence"

ⓑ **문장을 끝맺을 때 "too" / "however" 또는 다른 접속사로 끝맺지 마라.** (물론, "however"으로 문장을 끝내는 건 종종 사용되지만, 그건 짧은 문장을 때만 허용된다.)

ⓒ **"Then"을 문장의 시작 부분에 쓸 때 주의해야한다.**
"Then"은 "Therefore"의 뉘앙스로 쓰는 것은 적합하지 않다. 예를 들어, "Let us suppose the series converges. **Then** we can replace....(X)" 여기서 글쓴이의 의도는 "therefore"의 의미였을 것이다.
"Then"을 올바르게 사용한 예시이다. : "When (or if) we have supposed the series to converge, **then** we can....(O)"
물론, "then"을 "therefore"의 뉘앙스로 쓰는 것은 심각한 실수는 아니지만, 사람들이 많이 하

는 실수이기 때문에 주의하는 것이 좋다.

ⓓ **"especially"**는 형용사나 부사를 꾸며줄 때 주로 사용한다. 예를 들어, "It is **especially** important to....".
*※ 문장 전체를 꾸며주는 용도(Especially, we...)로는 사용할 수 없다. 문장 전체를 꾸며주는 표현을 쓰고 싶으면 **"In particular**"을 사용하는 것이 적합하다.*

ⓔ **"Somewhat"(어느정도, 약간, 다소) vs "more or less"(거의)**
- "Somewhat" ≃ "rather" / "quite" (see section XI)
(ex) "This is a **somewhat** doubtful procedure."
- "More or less"는 '다소'(多少)와 동치인 표현이 아니다.
(ex) "This is **more or less** established experimentally" ≃ "The experimental evidence **is not completely** conclusive **but it is very good**."

ⓕ **"a few"(어느 정도, 조금) vs "several"(몇몇의)**
- **"a few"**는 작은 수(the smallness of the number)임을 강조하는 뉘앙스이다.
(ex) "The strength of this interaction cannot be more than **a few** keV"
- **"several"**은 수식하는 것이 크다는 것(its largeness)을 강조하는 뉘앙스이다.
(ex) "Detection of this effect requires a field of **several** million oersteds".
※ 작거나 크거나를 강조할 필요 없을 때는 "a few"를 주로 사용한다.
(ex) "pp scattering at **a few** BeV is investigated."

ⓖ **"Based on"**
: "Based on"은 명사를 꾸며준다는 측면에서 형용사적인 어구이다. 즉, "**명사** + based on ..."처럼 써야한다.
예를 들어, "**Based on** the Landau theory, the magnetic susceptibility is investigated. (X)" 라고 쓰는 것은 "Based on ..." 앞에 꾸며줄 명사가 없기 때문에 틀린 표현이다. (그럼에도 불구하고 'Phys.Rev.'에 이 표현이 종종 출몰한다.)
이 경우에는 "**On the basis of** the Landau theory, the magnetic susceptibility is investigated. (O)"라고 쓰면 된다..
만약 앞의 예시에서 "based on" 앞에 이것의 수식을 받는 명사가 존재했다면 올바른 표현이다. 가령, "We give a treatment **based on** the Landau theory. (O)"에서는 "based on"이 "treatment"을 수식하고 있다.

ⓗ **"We had better..."(구어체) → "it is best to...."(문어체)**
: **"We had better..."**라는 표현은 구어체로 쓰는 표현이다. 문어체에서는 **"it is best to...."**를 사용하면 된다.

ⓘ "X and Y are equal **to each other**"에서 "to each other"은 그냥 지워버려도 전혀 의미의 모호함이 없다. 즉, "X and Y are equal."라고 간단하게 쓰면 된다.

ⓙ **"take place"과 "occur"의 의미 차이**

- Events "take place" *or* "occur".

: 이벤트는 "take place" 하거나 "occur"되는 거다.

- Poles (of propagators etc.) "occur" *or* "appear" (not take place).

: 하지만 프로파게이터의 폴들은 "occur"이나 "appear"하는 거지 "take place"하는 것은 아니다.

ⓚ "The functions F_i's" (functions가 복수인데, F_i's가 또 복수로 나온다.)

→ "the F_i's" 또는 "the functions F_i" (그래서 둘 중 하나만 복수로 쓰는 것이 올바른 표현이다.)

① 공식 이름에는 만든 사람들의 이름을 하이푼으로 연결해서 "The **Okubo-Marshak** formula"라고 쓰지만 이 둘의 이름을 인용할 땐 "**Okubo and Marshak** have shown...."라고 써야한다. "**Okubo-Marshak** have shown"라고 쓰면 절대 안 된다.

※ 물론 이름들 자체에 하이푼이 들어가는 사람들(Gell-Mann, Lennord-Jones, etc.) 도 있다. 이 경우와 혼동하진 말자.

Notes on the Writing of **Scientific English for Japanese Physicists**

Anthony J. Leggett
Nobel Laureate in Physics, 2003

Introduction

The main guiding principles I have used are the following. First, it is much more important that the English written by Japanese authors be clear and easily readable than that it be elegant. Therefore, in a situation where there is a choice between an elegant form of expression which, however, may easily lead to confusion if misused and a less elegant but practically "foolproof" one, I have never hesitated to recommend the latter. Secondly, the importance of avoiding a mistake is roughly proportional to the amount of misunderstanding it may entail and/or the amount of psychological "wear and tear" it may cause on the reader's nerves. Accordingly, I have spent a good deal of space on "macroscopic" points like sentence construction, and proportionately less on "microscopic" ones like the correct use of "a" and "the"; prepositions, which most Japanese writers seem to consider a major point of difficulty in writing English, I have scarcely mentioned, not only because this is the sort of point for which one can easily refer to dictionaries but because I believe the reader can usually correct any mistakes for himself with very little mental effort. Thirdly, the usefulness of a set of notes such as this is much reduced if the rules given become too complicated. Therefore, rather than give a complicated set of rules which would ensure correctness 100% of the time, I have often preferred to give a simple rule which will be right 95% of the time, provided that in the other 5% of cases, it is unlikely to lead to confusion. I do not claim that anyone who tries to follow the advice given here will write beautiful or even invariably correct English; but I hope that what he writes will be clear and readable and that any mistakes he does make will be minor ones.

The order in which the subject-matter is arranged is, roughly speaking, from "macroscopic" to "microscopic"; consequently, the points covered in the earlier sections are of more fundamental importance but the advice given is necessarily somewhat general and vague, while the latter sections cover more detailed points where fairly precise rules can usually be given. I hope any notation used will be self-explanatory ("A g B" means A is incorrect and B is the correct replacement). Most of the sentences quoted as examples of typical errors are either entirely my own invention or are substantially changed from their original forms; it is not claimed that they necessarily make sense as physics.

I should like to express my gratitude to Dr. K. Nishikawa, who generously devoted a good deal of time to constructive criticism of these notes. The responsibility for the opinions expressed remains of course entirely my own.

General

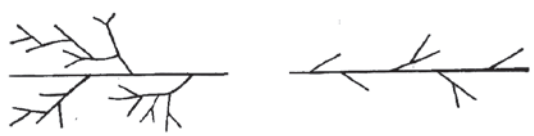
At first sight, it is tempting to think that the problem of writing good English is solved if one can write good Japanese and then give a perfect translation. I believe this is not necessarily true. "Japanese English"[1] has the peculiar property that it can be grammatically perfect and yet, if not completely unintelligible, at least "opaque" and baffling to the average English reader. This property is often shared by English translations (even by expert translators) of articles written originally in Japanese; it is clearly, therefore, not due to bad translation.

I believe, therefore, it is necessary to recognise that some patterns of thought which are acceptable in Japanese may

be unintelligible or puzzling in English (and, no doubt, vice versa). Moreover, ways of saying things which make sense against a Japanese background may either be nonsense or give quite the wrong impression when interpreted against a Western European one. (For instance, if you state a conclusion tentatively or indefinitely, a Japanese reader will understand that this is because you do not wish to be too blunt or assertive, but a European reader will often conclude simply that you are not really sure about it). Since, presumably, the vast majority of your readers will share the Western European background, it is necessary to make allowance for this fact. Of course, this problem is less important in scientific writing than in some other kinds, and the vast majority of Japanese physicists obviously recognise and make allowances for it; however, when it is not recognised the resulting confusion is so deep-seated that it is worth emphasising in some detail.

Here are some ways in which I believe acceptable modes of expression may differ in English and in Japanese.

1) In Japanese it seems that it is often legitimate to state a number of thoughts in such a way that the connection between them, or the meaning of any given one, only becomes clear when one has read the whole paragraph or even the whole paper. This is not so in English; each sentence should be completely intelligible in the light only of what has already been written. Moreover, the connection between one thought and the next should be completely clear when it is read; for instance, if you deviate from the "main line" of the thought to explore a side-track, this should be made clear at the point where the side-track starts, not where it finishes. Perhaps this is the best illustrated by the following diagram, where the "direction of reading" is from left to right:



(A) (B)

To an English reader, the Japanese pattern often seems to be like (A), whereas only (B) is usually allowable in English. Notice also that the tree in (B) has only a few branches; in English it is usually not a good thing to wander too far off the "main track". [2]

2) In English the sequence of thought should always be made quite explicit, even when, in Japanese, it would be legitimate to leave the reader to fill in the connection for himself. A common vice of J.E. is the writing of sentences like "It is uncertain whether this resonance should be assigned to the (56) or (82) representation, though Jones has suggested that its spin is 1/2" (where the reader is left to fill in "which, if true, would force us to assign it to the (56) representation"). Of course, to some extent what you may safely leave out depends on the degree of background knowledge you are presuming in the reader, but it is much better to be over-explicit than not explicit enough. Western readers sometimes compare J.E. to a classical Japanese painting; the reader has to fill in most of the picture for himself. If he is used to doing this, of course, it presents no great difficulty, but most English readers are not and the effect is merely bewilderment.

3) In English it is essential to be precise and unambiguous. You may sometimes feel that it is advantageous to leave a certain amount of ambiguity in a statement, — a certain amount of "room for manoeuvre" as it were; but this is never allowable in English. Ask yourself continually "what exactly does this sentence mean?" If you can't answer this question, it is usually best to leave the sentence out altogether.

Similarly, when you write an "it" (or "which," or "this," etc.) always ask yourself "what?" An "it" in English should always refer to something definite,[3] and moreover something which has already been mentioned in the text (it may of course be something quite complicated, like "the fact that...." — in this case the word "fact" itself of course need not have occurred). Too many Japanese writers appear to use "it" to refer to something which they have in their minds and they expect the reader to have in his!

4) Japanese seems to have a strong tendency to avoid too definite or assertive a statement, possibly because it is thought presumptuous to impose one's own views on the reader without conceding that there are possible alternatives. This notion is completely foreign to most Western readers, and they will usually be unable to make the "mental jump" necessary to appreciate it; if

[1] Hereafter abbreviated J. E.

[2] If you want to make a lengthy excursion, it is often better to do so in a footnote.

you state your opinion vaguely because you want to leave room for various possible interpretations besides your own, they will often simply take this as a sign of vague and muddled thinking.

Therefore, try to be as definite and assertive as possible, even it feels a little unnatural. If you have definite, concrete reservations about your views, or conclusions, then state them explicitly (in a footnote if necessary); if not, then don't try to soften the force of your assertion at all.

In particular, it is almost hopeless to try to translate phrases like "であろう", "といってよいのではないかと思われる", "と見てもよい" etc. into English (see also section 6); if you find you have to think out your sentence in Japanese and then translate it (a process which is of course not to be recommended but may be unavoidable for many people) then before translating change the first to である and leave out the second and third altogether.

5) To an English reader, Japanese (and J.E.) often seems vague and diffuse — there seem to be many clauses or sentences which add nothing substantial to the meaning. In English, on the contrary, every clause should "pull its weight". In particular, it is a very bad habit to imply vaguely that there is something more to be said unless you intend to say it explicitly. Thus, sentences like the following should usually be avoided:[4]

"This may give a very definite picture."

"This may be viewed from the standpoint of various considerations."

"It will be essential to study the problem from this point of view."

"This is useful not only for.... but also for examination of the effect from various sides."

Such sentences are quite legitimate if they introduce an explicit discussion; for instance, the first is all right if you go on to describe the "definite picture" or the second if you go on to enumerate the "various considerations". However, it is definitely a sign of bad writing in English to use them in isolation as a substitute for an explicit discussion. If this were merely a matter of good style one might afford to neglect it without serious confusion; however, I believe it is just such sentences which make a major contribution to the peculiar "opaqueness" of some J.E..

The point is that the English reader is not usually expecting such sentences in isolation, and therefore if you make "microscopic" (grammatical and other) mistakes in it he will often be unable to guess the intended meaning from the context. Therefore, if you don't want to state an idea or set of ideas explicitly, don't refer to them at all.

To summarise: make sure that your argument runs as a logical *sequence* and that no essential steps are left unwritten, be as precise, unambiguous and explicit as you can, and don't hesitate to state your conclusions boldly and definitely. Once this is done, the problem of writing good English is indeed largely reduced to the problem of good translation.

Sentence Construction

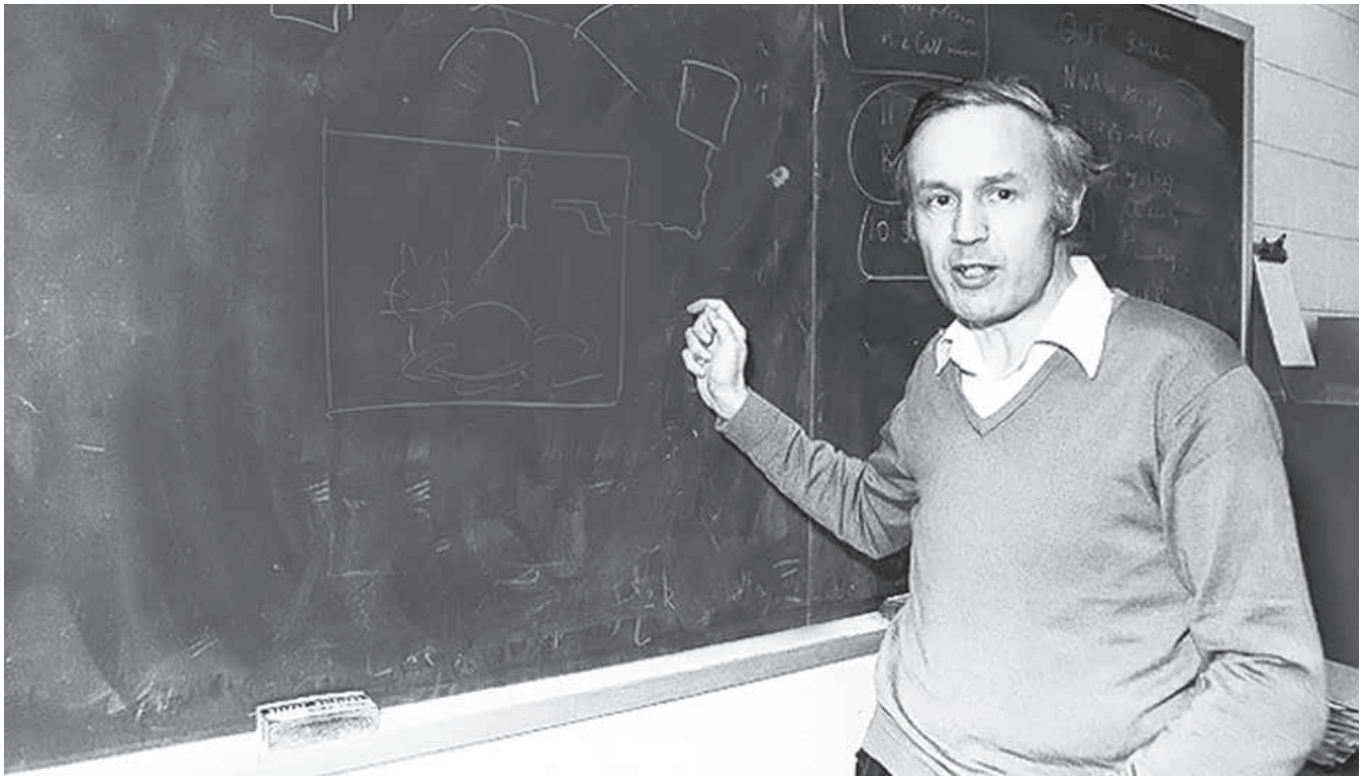
Write short sentences.

This may seem unnecessary advice since random sampling shows that the average sentence in "Progress" is already a good deal shorter than that in "Phys. Rev."; you may in fact sometimes hear Westerners criticise J.E. on the grounds that the sentences are too short and it reads jerkily. To some extent this is true, but this is a small defect and it is very much less wearing on the nerves to read a succession of short sentences, with the connection between each properly indicated, than to have to try to sort out a long and ill-constructed one.[5] The shorter the sentence, the less the chances of serious ambiguity. So, if your sentence is more than 40 words long, you should think seriously whether you cannot break it up

[3] Except of course in certain special grammatical constructions, such as "it is clear that..."

[4] The isolated examples given here are in fact unlikely to lead to very serious confusion. To give an example of a sentence of this type which could completely baffle the reader would require writing out the whole context.

[5] To some extent jerkiness can be avoided by replacing some of the full stops with semi-colons (see below).



Young Prof Leggett giving lectures to his students.

with at least a semi-colon (see below); as to the average length of a sentence,[6] 20 words is a good average to aim at and even 15 is probably not too short.

Remember in any case that the English sentence is a system of strictly limited capacity; it can tolerate only a few subsidiary clauses and these must all be fitted tightly into the sentence structure. *There is no analogue of the Japanese "suspensive" construction in English.* The following points should be given special attention:

a) If you have an important idea to express, don't put it in a subsidiary clause. Instead, start a new sentence. For example, consider the following sentence:

"Compared with the Nagoya model, these newer models seem to be rather more plausible in explaining the mechanism binding the baryons and leptons, by introducing a third quantum number besides the usual isotopic spin and hypercharge and by considering the existing baryons and bosons to represent a neutral state of this quantum number, although they must generally produce many particles so far undiscovered, as a result of the increased number of elements and the reduced symmetry."

This sentence (76 words) is much too long on general grounds. In addition there are presumably three different important ideas in it:

1) The newer models are better than the Nagoya model in explaining the binding mechanism.

2) The origin of this superiority is the introduction of a third quantum number, etc..

3) Nevertheless they predict many particles so far undiscovered. Each of these ideas deserves a sentence, or at least a main verb, to itself. Thus,

"Compared....leptons. This is because they introduce....number. However, they must.... symmetry."

This point applies particularly to sentences containing a long relative clause as the final part. For instance, consider:

"From eq. (3.10) we get the final result that the inelastic shadow scattering must dominate the cross-section above a few tens of BeV, if we

[6] That is, (number of words) / (number of periods plus semi-colons).

assume SU(6) symmetry and take the parameter λ to have a reasonably small value, which is in strong disagreement with the experimental results unless we assume a very peculiar form for the function f (S), as was shown by Brown from considerations of crossing symmetry."

Again this sentence is too long, and in addition the fact that the result is in disagreement with experiment is an important new point. Thus,

"From....value. This result is....symmetry."

(Another good reason for breaking up the sentence in this way is that as it stands it is not clear what the "which" refers to — see also below (section 3)).

b) Don't suspend a subordinate clause or phrase at the end of a sentence when it is not perfectly clear what it refers to. Be especially careful with clauses beginning with "as" "similarly to" or "by (in) ....-ing." A very common and misleading type of case is the following:

"We find that the function F(x) has an infinite range but the magnetisation below T_c does not tend to a finite value, as was suggested by Brown."

From this sentence as it stands the reader who is unfamiliar with Brown's work may draw any one of three conclusions about his suggestion:

1) The function *F* has a finite range and the magnetisation does not tend to a finite value.

2) The magnetisation does not tend to a finite value (no conclusion about F).

3) The magnetisation tends to a finite value.

It is easy to remove the ambiguity by breaking the sentence up into two, either by a full stop or by a semi-colon (see below). According as the meaning is 1), 2) or 3) we should write:

1) **"We find.... value. These results agree with the suggestion of Brown."**

2) **"We find.... value. This second result agrees with...."**

3) **"We find.... value. This second result conflicts with...."**

This is not necessarily always the most natural way of removing the ambiguity but it is by far the safest. Compare also the sentence:

"This feature seems to be disadvantageous to the collective nature of the excitation.... especially in bringing about a large transition probability."

As it stands it is not clear whether this means that the feature in question does or does not bring about a large transition probability (though I think most readers would assume that it does). Again a straightforward way of removing the ambiguity is to start a new sentence:

"In particular, it brings about...."

or

"In particular, it cannot bring about...."

In short, whenever you are tempted to write a subsidiary clause after the main one, ask yourself whether it wouldn't be better to start a new sentence. This may sometimes be the less elegant alternative but, provided it is grammatically possible, it is rarely wrong and the gain in intelligibility usually amply compensates for the loss in elegance!

Use of the semi-colon.

Too many Japanese authors (like many English ones, unfortunately) seem unaware of the existence of this punctuation mark (;). Roughly speaking, it is used to break up a long sentence when the ideas are too closely connected to be put in separate sentences; it indicates a break in the thought considerably stronger than that implied by a comma but weaker than that implied by a full stop (period). For grammatical purposes it is equivalent to a full stop. Thus, consider the sentence.

"High energy scattering above a few GeV is investigated as the shadow scattering of multiple production, for which phenomenological, peripheral and uncorrelated jet models are used."

In this sentence the clause beginning "for which" is important enough to stand by itself, but since it is so short and so closely connected with the rest of the sentence a full stop would give an unnecessarily jerky effect. Thus, use a semi-colon:

"High energy.... production; phenomenological.... used."

In many other cases, when you are tempted to start the second part of a sentence with "...., which...." or "...., and it...." it is much better to put a semi-colon: "....; this (result)...." etc.. In most cases it is largely a matter of taste whether to use a semi-colon or a full stop. (But remember that it is unusual for a sentence to contain more than one semi-colon.) However, ample use of the semi-colon will help to avoid over-clumsy sentences while giving a less jerky effect than a sequence of completely detached sentences.

Keep qualifying phrases and clauses to what they qualify. Consider the sentence:

"We investigate the scattering of pions by protons at a few MeV, paying special attention to the problem of the imaginary part of the phase shifts, which was previously discussed by Jones, who assumed a hard-sphere potential, in the SU_3 model."

As it stands it is not clear whether "in the SU_3 model" refers to "discussed by Jones" or to "we investigate." In either case it should follow the verb directly "discussed in the SU_3 model" or "we investigate, in the SU_3 model,...." (Actually this sentence would in any case better be broken up, with a semi-colon after "shifts".)

Similarly consider:

"The theory can explain the magnetic moments of the baryons, the approximate SU(6) symmetry scheme satisfied by all low-lying resonances and the fact that the scattering amplitudes appear to be well predicted by the Smith formula in a unified way."

Here it looks as if "in a unified way" qualifies "predicted" whereas it presumably is actually meant to refer to "explain." Thus we should write

"The theory can explain in a unified way the magnetic moments.... Smith formula."

Prof Leggett having a light moment with students.

Try to avoid qualifying a word by more than one phrase or clause; if this is unavoidable it is generally better to put the shorter and less important one first. Thus, e.g.

"We can carry out the integration in a straightforward way by making the substitution $x= y^2$ and transforming to polar coordinates" (not "we can... integration by making.... coordinates in a straightforward way").

Above all, make sure that qualifying clauses and phrases qualify something which is *actually in the sentence*, not something in your mind.

Typical of a common fault in J.E. is the sentence

"The proton and neutron masses are different by considering the effect of the pion cloud."

"By considering" here is obviously meant to qualify some unwritten verb like "understand" or "explain", but this is not allowable in English, so we must write, e.g.

"We can understand (explain) the fact that the proton and neutron masses are different by considering...." (or, of course, "the proton.... are different because of the effect....")

This particular example is fairly easy to disentangle, but I have read many similar ones where this mistake could make the sentence quite unintelligible.

In short: remember that in English every subsidiary clause and phrase must have a definite place in the sentence structure, and that as far as possible this place should be clearly indicated by the sentence order. Don't hang subsidiary clauses on to the end of a sentence if you are not sure just where they fit in — start a new sentence instead.

Relative Clauses (.."which....", "who....", etc.)

English distinguishes quite sharply between two types of relative clauses (as far as I know, Japanese does not make this distinction explicitly): those which identify and those which describe or state a further fact about the subject of the clause. In the second type a comma is put before the "which", in the first it is omitted. Thus, distinguish the two sentences:

a) "We find the solution of eqs. (8–10) which remains finite as $x \to 0$."
b) "We find the solution of eqs. (8–10), which remains finite as $x \to 0$."

Sentence (a) implies that there are (or at least may be) other solutions which do not remain finite; it *identifies* the solution which we find. Sentence (b) on the other hand implies that the solution is unique (otherwise the "the" would be replaced by "a" (see section 9)) and, further, states that it remains finite. In this case and in many similar ones we could rewrite (b) as:

"We find the solution of eqs. (8–10); this remains finite as $x \to 0$."

In fact it is probably better to rewrite it this way whenever it is grammatically possible. But, in any case, remember that the insertion or omission of a comma can change the meaning entirely.

Generally speaking, a relative pronoun (in either of the senses a) or b)) should immediately follow the noun to which it refers. (This is always true for type-b sentences) "Some solutions were obtained by Jones which satisfy (3.9.)" is best avoided;[7] and "the pion parity which is emitted in the reaction" is never allowable (it is the pion which is emitted, not the parity).

A common case in which this rule does not apply is when the noun is qualified by some other phrase as well as by the relative clause: e.g.

"the solution of eqs. (8–10) which remains finite" [type (a)],

"the solution found by Smith, which remains finite" [type (b)].

Be very careful to avoid ambiguity, however, in this kind of sentence; in the above examples both grammar and sense tells us that "which" must refer to "solution" and not to "eqs. (8–10)" or to "Smith", but in other cases it may not be obvious. Consider for instance:

"Let us consider the solutions of the equations which were found by Jones" [type (a)]

[7] This construction is sometimes legitimate but it is difficult to give a general rule.

"One then gets periodic solutions to the dynamical equations, which agree with those found by Jones" [type (b)].

Did Jones find the equations or the solutions? A reader with a detailed background knowledge of the subject may know, but you should never take such background knowledge for granted if you can possibly avoid it by rewriting the sentence in an unambiguous form. In a type-b sentence this is very easily done by starting a new sentence after "equations": "....equations; these equations agree.." or "....equations; these solutions agree...." as the case may be. Case (a) is rather more difficult; a somewhat inelegant but foolproof way of removing the ambiguity is to replace the "the" in front of the noun to which the "which" refers by "those":

"Let us consider those solutions of the equations which were found by Jones"
or
"Let us consider the solutions of those equations which were found by Jones."

Again, the sentence

"We consider the irreducible subspaces of the space to which P and Q belong"

may be ambiguous under certain circumstances; it can be made unambiguous by rewriting it, according to the meaning, either as

"We consider those irreducible subspaces of the spaces to which P and Q belong"
or as
"We consider the irreducible subspaces of that space to which P and Q belong."

If you do not do this, then generally speaking an English reader will tend to take the "which" as referring to the last noun to which grammar and sense permits it to refer (that is, to "equations" and "space" in the examples given above). Remember that the use of "that" and "those" in conjunction with "which" is confined to type-a relative clauses.

Make sure "which" actually refers to something.
A type-b relative clause occasionally appears not to refer to any noun which actually appears in the sentence, as in:

"This argument predicts that the spin of U is 3/2, which is in contradiction with experiment."

Here the "which" actually refers to "[the prediction] that the spin is 3/2". However, this kind of usage is full of pitfalls and I would therefore advise Japanese writers not to use it if they can possibly avoid it; one of the most widespread vices of J.E. is the writing of relative clauses which apparently do not refer to anything. It is almost always possible to avoid this by beginning a new sentence and referring to the noun explicitly: e.g.

"This argument predicts that the spin of U is 3/2; this *prediction* is in contradiction with experiment."

(The same warning, incidentally, applies equally to "this" and "it" — see section 1)

"Any and "All" especially in Negative Sentences

Consider the following two cases:

(a) $\alpha_1 \neq 0, \alpha_2 \neq 0, \alpha_3 \neq 0, \alpha_4 \neq 0$

(b) $\alpha_1 \neq 0, \alpha_2 \neq 0, \alpha_3 = 0, \alpha_4 = 0$

We can describe each of these cases in a number of ways: ((3)–(5) would of course be correct only in an appropriate context)

(a)
1) "All of the α's are different from zero."
2) "None of the α's are equal to zero."
3) "We have set all of the α's different from zero."
4) "We have set none of the α's equal to zero."
5) "We have not set any of the α's equal to zero."

(b)
1) "Some of the α's are different from zero."
2) "Not all of the α's are equal to zero."
3) "We have set some of the α's different from zero."
4) "We have not set all of the α's equal to zero."

However, we can never say[8]

"Any of the α's are not equal to zero"
or
"All of the α's are not equal to zero"

[8] "All.... are not" occurs occasionally in spoken English in sense (b). However, it is practically unknown in written English.

It is best to use the rule that "any" can never directly precede a negative, though it can follow it (as in (5a)). If you are tempted to write, e.g., "Any mesons are not stable," think carefully whether you mean "No mesons are stable" (= "all mesons are unstable") or "Not all mesons are stable" (= "some mesons are unstable"). In my experience, Japanese writers who write "any....are not" usually mean "none.... are"; on this assumption the following replacements should be made:

"Any problems.... do not occur"
→ "no problems....occur"

"Anything.... cannot be done"
→ "nothing.... can be done"

(or { "We can do nothing" / "We cannot do anything")

"Anyone.... has not proved"
→ "no-one has proved."

"This series does not ever converge" is not actually wrong, since the "ever" (which is analogous to "any") follows the negative, but "This series never converges" is much more natural. On the whole it is better to replace "not.... any" by "none" or "no" whenever you can;[9] thus 4a) is preferable to 5a) under most circumstances.

"Any" and "all" in positive sentences.

The sentences

a) "All higher-order terms may be neglected"
and
b) "Any higher-order terms may be neglected"

have a similar but not identical meaning. a) Implies that higher-order terms certainly exist; b) makes no such implication, but simply says that if they do exist, they may be neglected. "Any" is especially common before a relative clause, e.g.:

"Any interaction which breaks the symmetry will change the results"

The rule about "any" not preceding a negative does not apply, of course, if the negative is in the relative clause; thus the above example could be rewritten.

"Any interaction which does not conserve the symmetry will change the results."

"Only", "Mainly", "Not Only"

The positioning of "only" is very important.[10] Contrast the three sentences:

1) "Only the spin-orbit interactions renormalise the lifetime" (i.e. other interactions do not renormalise it).

2) "The spin-orbit interactions only renormalise the lifetime" (i.e. they have no other effect).

3) "The spin-orbit interactions renormalise only the life time" (i.e. they do not renormalise anything else).

It is best to try always to put "only" immediately before the word which it qualifies.

Thus, if $f(x,y) = x^2 + y^2$, $g(x,y) = y^2$, write "only f is a function of x" while if $f(x,y) = x^2$, write "f is a function only of x". Avoid "f is only a function of x" or "f only is a function of x" which are often ambiguous. If in doubt, it is often possible to rewrite the sentence to make the point quite clear: e.g. we could rewrite 1), 2) and 3) above respectively as

1) "It is only the spin-orbit interactions which renormalise the lifetime."

2) "The only effect of the spin-orbit interactions is to renormalise the lifetime."

3) "The only thing renormalised by the spin-orbit interactions is the lifetime."

Very similar remarks apply to "mainly" (or "chiefly" "principally" etc.) In sentences 2) and 3) "only" could be replaced by "mainly" with the analogous meaning in each case. In sentence 1) this is also grammatically possible but for some reason it sounds rather odd and 1) would usually be rewritten "It is mainly the spin-orbit interactions which...."

"*Not only*": Like "only", this refers to the word which it directly precedes. Thus, e.g..

"Not only x but [also] y is divergent."

[9] In this respect usage is different in spoken and written English.

[10] Here I discuss only the adverbial use of "only". The adjectival use does not usually give trouble.

"x is not only divergent but [also] meaningless."

"x not only diverges but [also] contains a factor T^{-1}."

If the "not only" refers to the whole clause it is usually necessary to invert the order, e.g..

"Not only does x diverge but x contains a factor T^{-1}."

(However, "not only *x* diverges", though incorrect, is unlikely in practice to lead to serious misunderstanding.)

Finally (a somewhat disconnected point): "We have introduced only one free parameter" but "*x* is introduced as the only free parameter" (not "only one"). Also note "The only free parameters are *x* and *y*" (not "The free parameters are only *x* and *y*").

"May be" / "Can be" / "Is"

"*May be*" is not the equivalent of "であろう", which indeed is practically untranslatable into English (cf. section 1). The sentence "*y* may be a function of *x*" implies that you (the writer) *don't know* whether *y* is a function of *x* or not; if you use "may be" merely because you think "*y* is a function of *x*" sounds too blunt, the average English reader will be completely baffled. "May" in English has two main uses:

1) to indicate uncertainly, e.g. "this series may not converge" "the experimental data may be erroneous"

2) to indicate permissibility (in this sense it is often replaceable by "can"), e.g. "We may approximate this term by...." "this term may not be neglected".

"May" is *never* used in English just to make a sentence sound more polite (the connection between politeness and vagueness is completely unknown in English); so, if your sentence does not fit either of the above cases, don't use it.

If you feel you must find an equivalent for であろう at all costs, probably the best is "we may say that...." (sense (2) of "may"); but it is much better to be blunt and have done with it (cf. section 1) ("we may say that *y* is a function of *x*" sounds odd since this is presumably not a matter of opinion!). Note also that although "it may be interesting/plausible/possible that...." is not wrong, it is more usual to replace the "may be" by "is".

"*It is shown (proved, demonstrated)*" almost always refers to a definite occasion, very rarely to the fact that something can be proved, has been proved at some indefinite time in the past, or has been proved by the author but not published. Thus, "It *is* (was, has been) shown in ref. (6) that Z_3 is finite" or "It *is* shown in the Appendix that....", but "It can be shown that Z_3 is finite [but we shall not bother to do so here]". If this remark precedes a proof, then use "can be": e.g. "It *can be* shown as follows that Z_3 is finite:...." Similarly "The cross-section *can be* calculated as follows:...." Also note "*f (x) can be* rewritten in the form...." ("is rewritten" is sometimes allowable but "can be" is hardly ever wrong.[11])

"*It is thought (believed) that....*" almost always means "it is thought by people (physicists) in general that...." not "I believe that....". Thus "it is believed that the nucleus consists of protons and neutrons" but "*The present author believes* that this result is incorrect". Similarly "V is regarded as an effective field" means it is so regarded by physicists in general; if, on the contrary, this is a view which you are proposing, say "V may be regarded as an effective field" (sense (2) of "may").

Prof Leggett giving a class lecture at Nanyang Technological University (NTU) in 2008.

Other common errors of this type:

"is noted"
→ "is to be noted" or "may be noted" or "should be noted"

[11] "We rewrite *f(x)* in the form...." is of course equally good.

"is desired (that)...."
→ "is to be desired" or "is desirable"[12]

"is emphasised"
→ "is to be emphasised" or "should be emphasised"

"is hoped"
→ "may be hoped" or "is to be hoped"

With regard to the last, however, distinguish "it is to be hoped that this question will be investigated" (= I hope someone else will investigate it) from "it is hoped to investigate this question" (= I intend to investigate it myself).

Qualified Adjectives etc.

If an adjective or participle is qualified by a phrase, it must immediately precede it.

Examples:
"inverse relation of eq. (7)"
→ "relation inverse to eq. (7)"

"exchanged particles between them"
→ "particles exchanged between them"

"isobaric state of the initial one"
→ "state isobaric to the initial one"

"identical equations with (3.7)"
→ "equations identical with (to) (3.7)"

"relative order of magnitude to"
→ "order of magnitude relative to"

"an intermediate stage of the first two"
→ "a stage intermediate between the first two"

Be specially careful not to write, e.g. "their intermediate stage" instead of "the stage intermediate between them." or "its identical equation" for "an equation identical with it". Always think twice before translating その by "its" or "their". "Its", "their" etc. can replace only "of it (them)" and even then the replacement is not always correct.

In particular, if the "of" is directly connected to an adjective or adverb, as in "independent of" the replacement is never correct; thus, "the independent solutions of the wave equation" can be replaced by "its independent solutions", (or, though less naturally, "the independent solutions of it"), but "the solutions which are independent of x, cannot be replaced by "its (i.e. x's) independent solutions" — we must write "the solutions independent of it". When in doubt it is probably safer on average to write "of it (them)".

An even more misleading type of error is one like the following:

"this is a gauge-transformation invariant of the electron operators."

Here "of the electron operators" qualifies "gauge-transformation"; we must therefore rewrite the clause

"this is an invariant with respect to gauge-transformation of the electron operators."

"A" vs "The" vs Nothing

Probably this is one of the most difficult points in the whole of the English language for most foreigners (not only for Japanese!). Luckily it does not usually cause serious confusion if you get it wrong, so I only mention a few points.

"The" usually implies in some sense the uniqueness of the object you are talking about, while "a" (or in the case of the plural, the absence of an article) implies its non-uniqueness. Thus,

"The solution of (3.9) is given by (3.10)" implies that this solution is unique, while "A solution of (3.9) is given by (3.10)" implies at least that there may be other solutions. Compare the following pairs of sentences:

{ "$f(x)$ is an analytic function of x."
"$f(x)$ is the function of x defined by (3.11.)"

{ "$f(x)$ is a Bessel function" (there are many Bessel functions but only one Airy function.)
"$f(x)$ is the Airy function."

{ "Two components of the momentum commute with H" (assuming the system is three-dimensional).
"The three components of the momentum commute with H."

[12] However, note "it is desired to express y in terms of x" (= we wish to express....)

{ "Very small values of t are unphysical"
"The very small values of t given by eq. (6) are unphysical."

{ "We regard x and y as quantities independent of R."
"We regard x and y as the only unknown quantities in this equation."

The fact that the noun in question is qualified by a type-a relative clause (section 3) does not necessarily imply that it must take "the": e.g.

{ "We must look for the metal which has the highest transition temperature."
"We must look for a metal which has a high transition temperature."

"***X** theory*" vs "The ***X** theory*". This is not an important point but a fairly definite rule can be given. If X is the *subject-matter* of the theory, then "X theory": e.g. "solid-state theory" "electromagnetic theory" "superconductivity theory". When X describes the postulates or methods of the theory, or names its author (s), then "the X theory": e.g. "the quark theory" "the BCS theory" "the quantum theory of radiation".

Thus, Professor Yukawa formulated "the meson theory [of nuclear forces]" but Schweber *et al.'s* book deals with "meson theory". Possibly in 1976 there will be "quark theory" but at present there is only "the quark theory"!

In general, however, I would advise authors not to worry overmuch about "a" and "the"; there are many other points which deserve more attention.

Singular vs Plural

The following nouns are never or very rarely used in the plural.[13]

Nature, character, behaviour, notation, knowledge, information, (experimental) support, agreement,[14] emission, scattering, advice, encouragement.

In general abstract nouns describing a process or action are used in the singular unless you are referring to a number of different occasions on which the action took place. A very common example is "*discussion*": thus,

"We give a discussion of this point in section 5" (*not* "some discussions"),

but

"The discussions of this point given in refs. (7) and (8) are inadequate."

(However, "the discussion of this point given in ref. (7) is inadequate".) It is also conventional to thank one's colleagues for "helpful discussions".

"*Situation*" is used in the plural only when it refers to two or more distinct cases. Thus, "This situation is to be expected" (*not* "these situations") but "There is a superficial resemblance between our case and that studied by Smith, but the two situations are really entirely different."

"*Experiment*": one usually uses the singular if the sense is general, e.g. "in agreement with experiment" "according to experiment" "conflicts with experiment" "take the values of α from experiment". However, "the experiments of Jones" "high-energy *p-p* scattering experiments". (Distinguish, incidentally, "experiments" from "experimental data": One usually says, for instance, "the experimental *data* are subject to a large error".)

The following nouns are normally used in the plural when the sense is general; they are used in the singular only when you are referring to *one particular* property, etc:

Features, properties, aspects, characteristics, circumstances. Thus, e.g.: "let us examine (the properties/ some features/ various aspects/ the characteristics) of this problem." "In these circumstances....", but, e.g.: "The solution (2.8) has the peculiar property/feature/characteristic of being invariant under the interchange of x and y." "A disturbing aspect of this situation is that...." "The unfortunate circumstance that f diverges makes it impossible to...."

Notice in particular that one always says "transformation properties" "symmetry properties" but (usually), "Hermitian property" (this is the property of being Hermitian, whereas "transformation properties" does not simply mean the property of being transformed).

Words to Avoid or Use with Care

"Image" is practically never used in scientific literature.[15] "Concrete" is much less common in English than 具体的 in Japanese; it is best to confine it to phrases like "a concrete example" or "we chose a concrete form for the potential". "This may give some very concrete images" is typical J.E.:[16]

[13] On the rare occasions when they can be used in the plural, the singular is equally correct.

[14] In physics contexts, at least!

[15] Except of course in a technical sense, as in 'the image of the Fermi surface'.

[16] "Concrete image" = コンクリートで造つた仏像.In this kind of case there is really no good translation of 具体的.

if you must say it at all (cf. section 1) say "This may give a very definite (clear) picture". *"Standpoint"* is also much less common in English than 立場 in Japanese; "from the standpoint of ...." is often best replaced by "in connection with [the fact that....]" or "in the light of (the fact that)...." Much the same applies to *"viewpoint"*. The words *aspect, character, nature, characteristics, features, circumstances, situation* seem to be particularly troublesome for Japanese authors; I can only recommend you to study their use when you read English papers, or use a dictionary which gives a large number of examples. Here is an example of the correct use of each:

"This equation has a Markoffian character."

"The true nature of
{ the forces binding the baryons
the random-phase approximation }
is still not well understood."

"The solution (4.3) has a number of interesting features."

"The principal characteristics of the solution are as follows."

"Various aspects of this problem remain insufficiently explored."

"In view of the circumstances mentioned above, experimental detection may prove difficult."

"The situation here is entirely analogous to that encountered in p-p scattering."

In certain cases two or three of these words may be interchangeable (cf. the example in section 9), but it is rash to assume that this is always so.

Miscellaneous

Note the following pairs, which are often confused:

{ "Ferromagnetism is usually attributed to the electron spins."
"The electron spins are usually invoked to explain ferromagnetism."

{ "The nucleus consists of protons and neutrons."
"Protons and neutrons constitute the nucleus."

Prof Leggett engaging in discussion with his students.

If f (x,y) = f (x), then
{ "f is independent of y."
  "[The value of] y is irrelevant to f."
(unusual)

If f (x,y) = x^2 exp – y^4, then
{ "f is sensitive to the value of y."
  "The value of y is critical for f."
(unusual)

"Necessarily does not...." vs "does not necessarily": "*CPT* invariance does not necessarily imply *T* invariance" but "If the mass of the fission fragments is greater than that of the parent nucleus, then fission necessarily does not occur" (= cannot occur). The second use is however rare and best avoided.

"Both" vs "the two": "Both" in English has the sense of 両方とも; thus "both the renormalisation constants are equal to unity" but "the two renormalisation constants cancel one another." "Both renormalisation constants are equal" (i.e. to one another) → "the two r. cs. are equal".

"Quite" vs "considerably": The meaning of these two words is often very similar but "considerably" is usually used only when a comparison is stated or implied. Thus "*x* is considerably larger than *y*" "*x* is considerably reduced" but "*x* is quite large". Actually "quite" is a rather ambiguous[17] word and it is often safer to replace it by "rather".

Note the following expressions which are listed roughly in order of increasing strength:

"X is a little larger/somewhat larger/rather larger/ considerably larger/ a good deal larger/very much larger than Y."

"X is fairly large/ quite large/rather large/very large."

(Actually in the second row "fairly" "quite" and "rather" are almost indistinguishable.)

"Namely" vs "that is": *"Namely"* is used when you are about to *name* or *identify* something you have already described: e.g. "Using the best available data, namely these of Brown..." or "There is one difficulty. Namely, the integral in (3.1) does not converge." "That is" is used to introduce an explanation of something you have said, e.g. "Region II, that is, the region in which the heavy mesons play a dominant role...." or 'The validity of this procedure is doubtful. That is, it is not clear that we can replace...." In my experience "that is" is right 90% of the time, especially at the beginning of a sentence.

"will be able to be replaced" → "can be replaced"

"may have a possibility to" → "may be able to" or "can"

"suggests us that" → "suggests that"

"formulae (expressions) for f " (not "of f ")

"conditions (restrictions) imposed on M by rotational invariance" (not "to M")

"effect of the Coulomb terms on S" (not "to S")

"X can be expressed (rewritten) in terms of Y" (not "by Y")

"construct the wave function from Bloch waves" (not "with")

"X is insensitive in comparison with Y" but "X is less sensitive than Y"

"associate A with B" (not "to")

"The concerned baryon" → "The baryon concerned"

$\sum_p$ is "a summation over p" (not "of p")

"our interesting amplitude" → "the amplitude of interest to us"

"We pick up the ring graphs" → "pick out" or "isolate" or "select for special treatment"

"operating $\partial/\partial X_\mu$ on ψ" → "operating with $\partial/\partial X_\mu$ on ψ"

Minor Stylistic Points

Try not to start sentences with "and", "but", "so".[18] Instead of "and" use "moreover" or "further", instead of "but" use "however" or "nevertheless"; instead of "so" use "therefore" or "hence". Don't end sentences with "too" or "however" (or

[17] "The effect is quite strongly suppressed" = "suppressed to a large extent but not completely." "The effect is quite suppressed" = "completely suppressed."

[18] This is another point in which spoken and (scientific) written English differ.

Prof Leggett with NTU's CN Yang Scholars at the dialogue discussion in 2010.

indeed any conjunction), though "however" is sometimes allowable at the end of a very short sentence.

Be careful about starting sentences with "Then". It is *not* legitimate to use this in the sense of "therefore". Japanese authors are probably confused by sequences like: "Let us suppose the series converges. Then we can replace...." The "then" here does *not* mean "therefore"; the sense is "when (or if) we have supposed the series to converge, then we can...." Although the use of "then" for "therefore" is not a serious mistake, it is very widespread and worth watching out for.

"Especially" usually qualifies an adjective or adverb ("It is especially important to....") not a whole clause. At the beginning of a sentence it should usually be replaced by "In particular".

"Somewhat" vs "more or less": "This is more or less established experimentally" means roughly "The experimental evidence is not completely conclusive but it is very good." "More or less" is *not* the equivalent of 多少. "Somewhat" is roughly equivalent to "rather" or "quite" (see section 11) (e.g. "this is a somewhat doubtful procedure.")

"A few" vs "several": "A few" tends to emphasise the smallness of the number involved, while "several" tends to emphasise its largeness. Thus, e.g. "The strength of this interaction cannot be more than a few keV" but "Detection of this effect requires a field of several million oersteds". When neither emphasis is needed "a few" is usually used, e.g.: "*pp* scattering at a few BeV is investigated."

"Based on". This is an adjectival phrase and as such *must qualify a noun*. Sentences like "Based on the Landau theory, the magnetic susceptibility is investigated" are very bad English;[19] we should write "On the basis of the Landau theory, the m.s. is investigated". However, "we give a treatment based on the Landau theory" is correct, since "based on" qualifies "treatment".

"We had better" sounds very colloquial: it is best replaced by "it is best to...."

In the sentence "X and Y are equal to each other" the "to each other" can usually be left out without any danger of ambiguity.

Events "take place" (or "occur") but poles (of propagators etc.) "occur" or "appear" (not take place).

"The functions *Fi*'s" g "the *Fi*'s" or, better, "the functions *Fi*".

"The Okubo-Marshak formula" but "Okubo and Marshak have shown...." (never "Okubo-Marshak have shown".)

Of course a few Western names are actually hyphenated (Gell-Mann, Lennord-Jones, etc.)