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A Wobble between Certainty and Uncertainty: The Form and Function of If-Conditionals in Physics Discourse

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ABSTRACT

Conditionals are an essential subcategory of English syntax, reflecting scholars' evolving needs when arguing, debating, or softening statements. This study analyzes the form and function of if-conditionals in physics discourse across both written and spoken registers: the written register includes two specific sub-registers—research papers and editorials—while the spoken register comprises lecture talks. The initial findings contradict the results of some comparable studies. Despite the scientific nature of our data, pragmatic conditionals emerged as the most frequent not only in the spoken register but also in research articles and editorials. Examination of these conditionals shows that they serve different functions in each register. The majority of these conditionals, termed inference conditionals, were epistemic in nature and helped researchers conclude less subjectively, thereby allowing room for further speculation. The remaining pragmatic conditionals were found to be register-specific. Discourse conditionals appeared extensively in the oral register, where speakers primarily used them to engage their audience. Performative conditionals were exclusive to editorials, where they involved advice or recommendations directed at researchers. Our study underscores the importance of inference conditionals in the argumentation and negotiation of results. It also demonstrates that there is no one-to-one correspondence between the form and function of conditionals, as a single form can serve multiple functions, including indicating the coincidence of events, hypothetical situations, or epistemic meanings. Our study also has pedagogical implications for education policymakers. The teaching of conditionals in ESP classes needs to be contextualized, and explicit instruction is required.

Keywords: If-Conditionals; Physics Discourse; Pragmatic Conditionals; Spoken Register; Written Register

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1. Introduction

Depending on the communicative settings of a situation, we discriminate and prioritize a distinct linguistic variant[1]. Understanding and practicing these variants can foster mutual understanding among community members[2]. These patterns are analyzed through register studies, and examining their use can enhance the effectiveness of our messaging. This study adopted a text-linguistics approach, where the natural occurrences of linguistic features reflect the dominant patterns within a linguistic variant. The rationale behind this approach is that specific situations evoke certain linguistic features, and their use fulfills the communicative requirements of the register[3]. Among the various linguistic variants, academic prose has drawn significant attention as it involves many non-native scholars who need to articulate their ideas effectively in this style. Some of these studies have conducted analyses of lexicon-grammar. For instance, Simpson-Vlach and Ellis examined formulaic sequences useful for academic speech and writing, highlighting patterns frequently used in academic contexts[4]. Similarly, Lorés-Sanz found that English abstracts tend to be more inclusive, whereas Spanish abstracts often lack certain rhetorical moves[5]. Her study has implications for Spanish scholars seeking to interact more effectively with a global audience. Another group of studies has focused on individual linguistic features. For example, Parkinson examined modal usage in laboratory reports and essays across nine disciplines, highlighting the different functions of modality across various academic genres[6].

The linguistic feature we intend to analyze is the use of if-conditionals across different registers in the discipline of physics. Given that the type of discipline can initiate a specific register, this study focuses on the subject of physics while extending our investigation to both oral and literate registers. The oral register includes university lecture talks, while the written register comprises two specified sub-registers: research articles and editorials. Examining if-conditionals and the sequences of words that co-occur with them can help us recognize patterns that convey the discourse of physics.

As mentioned, analyzing academic prose has pedagogical implications for material developers[7]. Similarly, the results of this study could reveal the actual use of conditionals in physics discourse. Conditionals serve multiple functions in English discourse. They allow users to subject different aspects of research to debate and set the stage for making an argument[8]. Through their use, meaning is negotiated, and reasons are promoted[8,9]. They can even operate as face protection and soften the conversation[10]. Such a multifaceted nature requires an in-depth study tailored across each register within a particular discipline. Actual uses of conditionals in various genres, nevertheless, have not been explored enough, and except in some studies, many other fields have remained intact. For example, Ferguson, Carter-Thomson and Rowley-Jolivet analyzed conditionals in doctor–patient consulting conversations and in written medical texts[8,10]. Mead and Henderson dug them out in economic texts[11], and Warchal explored interpersonal interaction through conditional clauses in applied linguistics papers[12]. The significance of this study becomes even more evident when we consider that pedagogical materials and educational settings have, in some cases, failed to meet the needs of general English learners[13–15]. Furthermore, given the reasoning nature of this subject, a higher number of conditionals are employed in physics discourse[16]. Physics, therefore, is a discipline that deserves the teachers' and researchers' attention in conditional use. This research aims to spotlight the use of conditionals in physics across the spoken register of lecture talks and two written sub-registers: journal articles and editorials. The following research questions will be addressed:

1. What are the forms and functions of if-conditionals across oral and written registers in the discipline of physics?

2. What words or phrases co-occur with if-conditionals across oral and written registers in the discipline of physics?

2. Literature Review

2.1. Typology of Conditionals

Regarding classification, conditionals have been examined from several perspectives: morphology, semantics, and the relationships between their clauses. Because this study conducts a qualitative analysis of conditionals in real-world use, we limited our review to terminologies grounded in semantics and content.

Our investigation found the typology of Athanasiadou and Dirven particularly useful for this purpose[17]. Before

detailing our chosen taxonomy, it is helpful to consider other classifications that emphasize the content and meaning of conditions.

Ford et al.[18] demonstrated that conditionals provide a framework for subsequent discourse, identifying five functions of initial conditions: assumption, contrast, exemplification, generalization, and the opening of new possibilities. Comrie[19] did not classify conditionals into discrete groups but placed them along a likelihood spectrum, arguing that the more hypothetical a conditional is, the less frequently it occurs. He also maintained that a conditional's truth and counter factuality depend on pragmatic factors rather than on its content. Despite Comrie's generalizing approach, Sweester[20] distinguished between types of conditionals and proposed three levels: content, epistemic, and speech act. At the content level, a causal link exists between the two clauses: the antecedent condition sufficiently brings about the event in the consequent.

1. *If Mary goes, John will go.*

At the epistemic level, the relationship between the clauses is a knowledge-conclusion link, and speakers draw an inference on the antecedent grounds.

2. *If she's divorced, (then) she's been married.*

Finally, in speech act, the fulfillment of the speech act in the consequent depends on the state of the antecedent.

3. *If I may ask, what's the time?*

Following this typology, Athanasiadou and Dirven, whom we drew on, developed a more elaborate framework[17]. They analyzed the content and the kind of relationship between the clauses and introduced three types of conditionals:

4. *If there is a drought like this year, the eggs remain dormant.* (Course-of-events)

5. *If the weather is fine, we'll go for a swim.* (Hypothetical)

6. *If you are thirsty, there's beer in the fridge.* (Pragmatic)

In this framework, the course-of-event conditionals imply the natural cooccurrence of two events in the real world (general or repeated). The relationship between the events is mutual, and the event in the antecedent does not necessarily commit to the event in the consequent. Athanasiadou and Dirven identified three types of these conditionals shown in **Table 1**[17].

Table 1. Types of course-of-event conditionals.

Type	Definition	Example
Descriptive	Describes two events that are observed to occur together.	Temporary constipation is common during illness, especially when there is a fever.
Inferential	The implication in the main clause is based on inference rather than direct observation and applies to the actual situation.	If these reports are as good as they look, your staff should be getting a little more rest before long.
Instructive	The main clause gives an instruction that applies if the situation in the subordinate clause arises.	If there is more than one contributor, either assign separate responsibilities or pool the family income.

In contrast to course-of-event conditionals, the relationship between events in hypothetical conditionals is causal. Depending on the speaker's commitment to the likelihood of the situations, hypothetical conditionals are classified as unmarked or marked. In unmarked hypotheticals, the speaker's attitude toward the probability of the situation is neutral. By contrast, in marked hypotheticals, the speaker signals greater certainty or improbability about the event's occurrence. In extreme cases, some marked non-counterfactuals indicate that the event's occurrence would contradict reality[21].

Finally, in the pragmatic conditionals, the focus is on the interpersonal function of language and is strongly 'speaker-oriented' or 'hearer-oriented'. The lowest dependency rate exists between clauses that can be uttered as two independent clauses. The pragmatics have been introduced within two base categories of logical and conversational, each of which has two subcategories[22]. **Table 2** shows these categories.

The preference for this framework stems from its thorough, well-detailed categorization. The examples were drawn from an authenticated corpus and analyzed in context. By examining naturally occurring data, Athanasiadou and Dirven identified their functions precisely[17]. The realization of these functions is accompanied by a close examination of form—verb tense, discourse markers—and of the relationships between clauses.

Table 2. Types of Pragmatic Conditionals.

Type	Definition	Example
Identification	The speaker creates rhetorical impact by introducing an unknown or noteworthy entity.	If there is one species to be put out to pasture, it is the president.
Inference	The speaker infers a perspective or conclusion from observable evidence.	If she's divorced, then she has been married before.
Discourse	The speaker states the condition under which the communicative act is relevant.	If anyone needs me, I'll be downstairs.
Metacommunicative	The speaker highlights their stance by commenting on the appropriateness or nature of the speech act.	I've come to offer my congratulations, if that's the right word.

2.2. If-Conditionals across Registers

Ferguson examined if-conditionals across three genres of medical discourse—research articles, editorials, and doctor–patient oral interactions. His statistics showed that course-of-event conditionals predominated in all three genres, with the highest frequency in editorials, reflecting the reliance on established knowledge in that genre[10]. Although Ferguson described this predominance as an expected feature of scientific research, Carter-Thomas and Rowley-Jolivet observed somewhat different patterns of conditionals in a similar corpus[8]. The predominance of course-of-event conditionals was observed only in research articles; they accounted for one-third of conditionals in conference presentations and only ten percent in editorials. Conditionals in conference presentations were relatively evenly distributed, whereas editorials showed the highest incidence of discourse conditionals and an absence of factual (course-of-event) conditionals. This absence was attributed to editorials' lack of need to prove claims, and to their greater use of discourse markers for guiding readers through diagrams and figures. Louwerse et al. conducted a three-stage study of tutoring dialogues among physics students[16]. Their results showed a significantly high use of conditionals in the physics corpus and that expert students employed if–then markers more frequently. This finding confirms the importance of if-markers in the physics domain, as they reflect students' deeper knowledge in problem solving. Warchał investigated interpersonal conditionals, which writers use to elicit readers' consensus by appealing to shared understanding[12]. His corpus comprised 200 research articles in applied linguistics. The most frequent type was content conditionals, accounting for more than half of all conditionals; over one-fifth were epistemic, and speech-act conditionals made up about 6% fewer.

Warchał investigated interpersonal if-conditionals in 200 research articles in applied linguistics, adopting Sweetser's taxonomy as the macro-level framework for her analysis. Drawing on the pragmatic—functional perspective of Quirk et al.[23], she refined and elaborated Sweetser's speech-act category, distinguishing several interpersonal types of conditionals: speech-act conditionals, subdivided into politeness and relevance conditionals that regulate reader cooperation or justify the relevance of a claim; metalinguistic conditionals, which negotiate meaning and terminology; reservation conditionals, which limit authorial commitment due to possible uncertainty; concessive conditionals, which acknowledge alternative viewpoints while maintaining a claim; and rhetorical conditionals, which function as strong assertions despite their conditional form. The results showed that interpersonal conditionals, including epistemic and speech-act conditionals, account for approximately 43 percent of all conditionals in the corpus.

Drawing on Halliday's metafunctional taxonomy[24], Lastres-López distinguishes between ideational, textual, and interpersonal functions of conditionals[25]. In ideational conditionals, the speaker envisages a real or unreal cause–effect relationship between the antecedent and the consequent. In textual conditionals, the speaker organizes or steers the discourse, and interpersonal conditionals are those elaborated on by Warchał. The corpus of this study consisted of face-to-face conversations, and the results showed that in the oral register, interpersonal conditionals account for more than half of all occurrences, whereas textual conditionals are almost entirely absent. Her high use of interpersonal conditionals was attributed to the spontaneous and informal nature of oral communication.an interesting part of this study was the adaptation that she applied on the Warchał's taxonomy to fit her study. She also added another subcategory to speech act, named opinion and evaluation. As the name speaks for itself, at the consequent of these conditionals, the

speaker states their opinion and it is different from epistemic conditionals in way that is completely speaker-oriented and it is about the stance. An interesting aspect of this study is the adaptation that Lastres-López applies to Warchał's taxonomy in order to fit her data. She also adds an additional subcategory within speech act conditionals, termed opinion and evaluation. As the label suggests, in these conditionals the consequent expresses the speaker's opinion or evaluative judgment. Unlike epistemic conditionals, these constructions are entirely speaker-oriented and primarily concerned with the expression of stance.

3. Data Sample

For this study, the written register consisted of research articles and editorials, and lecture talks made up the spoken register. The first subset includes 30 papers from two prominent international journals: Physical Review Letters and Physical Review D. The second category comprises 70 editorials published in the same journals. Finally, the third category included 15 lecture talks delivered by high-profile professors.

While reviewing papers, we encountered many authored by groups of researchers. In physics, investigations are typically conducted by teams, and the papers report their collective results. To avoid the difficulty of identifying each author's demographic information, we excluded reports with more than three authors and tracked the corresponding author instead. Native English-speaking researchers have often dominated contrastive studies; however, we intentionally moved away from that bias, considering researchers' academic expertise. We were guided by studies showing that non-native writers are not necessarily disadvantaged and that familiarity with disciplinary conventions plays a more central role in academic writing[26,27]. This knowledge, which even English-native writers need to acquire, is gained through practice in the speech community. This aspect was examined using social networking websites, including Google Scholar, Research Gate, and LinkedIn.

Collecting the editorials was comparatively easier than collecting the research articles. Each editorial is written by a single editor, who is typically a highly experienced researcher in their field. For the lectures, we narrowed our investigation to those delivered by physics professors at the University of Oxford. This selection was based on the university's high ranking and the strong profile of its physics faculty. Care was taken to choose formal lectures from a range of physics subfields, and the lecturers' profiles were reviewed through their pages on the university website. Each lecture lasted approximately one hour and was transcribed for analysis.

After preparing the materials, the conditionals in each document were identified. The next step involved distinguishing the conditionals based on their functions, which proved to be a lengthy process. Although the categorization of conditionals was thoroughly developed, some instances were initially confusing because their differences were not immediately clear. However, by referring to the provided guidelines and examining their contexts, we were able to differentiate them, after which two linguists specializing in English reviewed and refined our categorization. A more detailed explanation of the conditionals and their subtle distinctions is provided in the discussion section. Once each category was organized, the conditionals were analyzed in terms of their verb tenses. Finally, the frequency of conditionals in each category was calculated.

Conditionals encompass a wide range of linguistic markers; however, this study focuses exclusively on if-clauses. We also did not take into account the ordering of conditional clauses. In what follows, the distribution of these conditionals and their semantic role in conveying meaning will first be discussed, after which their form will be analyzed with respect to verb tense and other notable features.

4. Findings and Discussion

The collected corpus, including research articles, editorials, and lecture talk transcriptions, was examined to identify the occurrence of conditionals and their function in the text. **Table 3** shows the frequency and ratio of conditionals in the data sample in each genre.

In our data, the frequency of conditionals in the spoken register (lecture talks) was approximately four times higher than in the written register (research articles and editorials). Similarly, Ferguson found that conditionals occur more frequently in doctor–patient dialogues than in research articles and editorials[10]. Ford et al. also reported a higher use of conditionals in academic transcriptions than in written books[18]. **Table 4** shows how pragmatic, course-of-events, and hypothetical conditionals are distributed across the three genres.

Table 3. Frequency and ratio of conditionals in data sample.

Genre	No. of Text	No. of Words	No. of Occurrences	Ratio of If per 1000 Words
Research article	30	136,033	75	0.5
Editorials	70	50,617	32	0.6
Lecture talks	15	58,917	117	2

Table 4. Proportion of pragmatic, course-of-events, and hypothetical conditionals across registers.

The Conditional Type	RA (n = 75)	ED (n = 32)	LT (n = 117)
Pragmatic	30(40%)	21(65%)	71(61%)
Course-of- events	27(36%)	3(9%)	34(29%)
Hypothetical	18(24%)	8(25%)	12(10%)

Contrary to the researchers' expectations, course-of-events and hypothetical conditionals were not the dominant types in scientific essays; instead, pragmatic conditionals were the most frequent not only in the spoken genre but also in editorials and research articles. The highest proportion of course-of-events conditionals appeared in research articles, reaching 36 percent (only 4 percent less than pragmatics). In contrast with this high incidence in research articles, their occurrence in editorials was only 9 percent—the lowest among the genres. In editorials, pragmatic conditionals constituted the majority (65%), while hypothetical conditionals accounted for one quarter. Although hypotheticals represented about one quarter of all conditionals in research articles and editorials, they had the lowest percentage in lecture talks, where pragmatic and course-of-events conditionals together comprised 90 percent of all instances.

The different pattern of conditionals requires a closer examination of their use in the context. In the following, we will show how conditionals vary in each genre and seek our answers by scrutinizing their functions. Then, we will focus on their forms by analyzing their verb tense in both clauses.

4.1. The Conditionals in Research Articles

4.1.1. The Pragmatic Conditionals in Research Articles

Despite the findings of previous studies, course-of-events conditionals were not the most frequent in research articles; instead, they ranked second after pragmatic conditionals. To better understand the reasons for this discrepancy, it is first necessary to provide a clearer picture of pragmatics by elaborating on Athanasiadou and Dirven's taxonomy and then examining what is meant by pragmatics in this context[22]. Athanasiadou and Dirven[22] divided pragmatics into two main subcategories: logical and conversational. The conversational category encompasses the speech-act and metalinguistic aspects of discourse, while the logical category concerns the logical relationship between the antecedent and the consequent. The logical pragmatic comprises two subcategories: identification and inference. In the identification domain, the speaker not only introduces an unknown entity but also creates anticipation to increase the impact of their words. In the inference domain, the given information in the antecedent is used to make an argument or a logical deduction[22]. The relationship between the clauses is neither simultaneous occurrence nor causative, but rather logical and fully speaker-oriented[22]. The inference pragmatic differs from the inference of the course-of-events in important ways. A course-of-events inference presents an observation or event to the reader as something new, while a pragmatic inference does not introduce a novel event; instead, it emphasizes the strength or implicature of the inference. For example, compare the following excerpts taken from the same research articles:

7. *If there are two (or more) Higgs doublets, one Higgs is responsible to the masses of third generation and quarks*

8. *One can avoid this bound easily if the X is some kind of leptophobic and/or photophilic scalar.*

While the first example illustrates a general observation and the natural inference drawn from the antecedent, the second example describes a possible event along with the writer's logical deduction. All of the pragmatic conditionals

identified in the research articles expressed inference, and they were used with similar verb tenses. In each case, the writer introduced a familiar situation, subjected it to speculation, and derived the intended conclusion.

Van Dijk described pragmatics as the conventional rules of language manifested in utterances[28]. In his view, an independent contribution is required to analyze the conditions that make an utterance acceptable. The analysis of inference conditionals in the research articles shows how authors used epistemic expressions or specific verb patterns to signal deduction. The examples below were selected from the corpus to illustrate the co-occurrence of inferential pragmatics with these linguistic signals:

> 'then' in the consequent, is maybe the most obvious marker in the inference pragmatic. To see how 'then' can make a change, compare these two sentences.

9. *The ALP lifetime is controlled ..., if $fg ~ f\gamma$.*
10. *If $n(k) = 0$, **then** none of the three bands are occupied.*

While the inference in (5) directly results from the observation, the assumption in (6) is a deduction made by the writer. The presence of then is seen as reflecting an earlier paratactic structure[29].

Similarly, we found other epistemic paraphrases that help the writers in reasoning, including 'meaning', 'indicating', 'implying'. The examples 7–13 show the use of these epistemic paraphrases.

11. *If the reference measurements are tomographically complete, **meaning** that they are sufficient to construct a complete representation of the underlying quantum system.*
12. *If one will find the favored lifetime is inside the parameter space excluded by $K\flat \to \pi\flat X$, it **indicates** the violation of the GN bound.*
13. *If the photons and missing energy in the signals are interpreted as $\pi 0v ¯v$, the KOTO single event sensitivity, 6.9×10^{-10} [6], **implies** $B\eth KL \to \pi 0v ¯v\flat KOTO ¼$.*
14. *If the pull is exactly proportional to the mass, **that means** that two objects of different mass will change their velocity.*

These conditionals are speaker-oriented and could also be paraphrased as 'we expect' or 'we estimate':

15. *If this phase transition leads to the formation of topological defects, **we expect** a stochastic gravitational wave from the dynamics of the defect network.*
16. *if super-Tonks-Girardeau-like anticorrelations could be responsible for the three-body loss suppression, **we estimate** the maximally feasible suppression due to elastic two-body scattering, only.*

In some instances, the writers bring an issue into focus and challenge the reader by posing a question.

17. *Are the laws of quantum physics the most natural ones to explain data from experiments if we assume no prior knowledge of physics?*

Ultimately, we found examples in our sample which were absent in Athanasiadou and Dirven's corpus:

18. *If so, it is possible that the NFL behavior in MABLG is controlled*
19. *If, instead, have $B\eth KL \to \pi 0invÞ¼B\eth KL \to \pi 0v ¯vÞSM$*

'due' is another linguistic feature which helps the writer to preserve the logical nature of clause.

Although we found several if-clauses combined with 'due', it is unlikely that they can be classified as deductive markers. Compare example 20, taken from Athanasiadou and Dirven's corpus, with the following example from our data[17]:

20. *But if there is a particularly wet season, this is **due** to the heavy rainfalls in the winter.*
21. *If there is mass near zero, then delays are minimal **due** to the presence of extremely fast mission routes.*

While in example (20) the cause of the wet season is attributed to heavy rainfall, in our example, 'due' is used to explain the reason for minimal delays, not the reason for near-zero mass. Therefore, this feature was absent in our data.

Building on the discussion of epistemic expressions in inferential pragmatics, we now turn to an analysis of their verb forms. **Table 5** illustrates their range, and as can be seen, the variation is largely restricted to the simple present and modal forms. For each category of conditionals, we consider the samples with the highest frequency.

Table 5. Present-tense and modal variation in if-conditionals in research articles.

	Pragmatic	Hypothetical	Course of Events	Total
Present + may, could,can	10	0	27	37
Present + present	8	3	0	12
present + should/has to	3	0	0	3
Present + will	1	10	0	12
Modal + modal	2	0	0	2
Will/would + present	2	4	0	4
Total	26	17	27	70

As shown in **Table 5**, 13 out of 26 pragmatics had the present tense in the antecedent and modal verbs (may, can, could) in the consequent. These conditionals focused more on the epistemic nature of the pragmatic inference and were identified with five different models.

The most common modal verbs were 'may', 'can', and 'could' in the consequent. In these conditionals, the writer utters an observation in the antecedent and deduces something in the following clause:

22. *The gravitational wave emission **may** be further enhanced if the difference between the gravitational radiation scale and gravitational backreaction scale is considered.*

23. *One **can** avoid this bound easily if the X is some kind of leptophobic and/or photophilic scalar.*

24. *If not, much **could** be done by a group with better access to computational power.*

'May' in two examples paraphrased into 'it is possible' and 'it is likely':

25. *If so, **it is possible** that the NFL behavior in MABLG is controlled*

26. *If Tcoh is nonzero, **it is likely** that the metallic regime…*

The second group of conditionals with a modal in the consequent was conditionals with 'should' and 'has to' in the antecedent:

27. *If this condition can be satisfied, it **should** be possible to obtain an efficient resonant*

28. *If the lifetime is too short, the branching ratio of KL → π0X **has to** exceed 1%.*

29. *To be effective, the encoding of body size **has to** be reliable and has to be present, even if other aspects of vocal communication change.*

These models are used primarily when writers discuss the likely outcomes of manipulating variables or conditions in an equation. Because of the mathematical nature of equations and basic formulas, any change in the variables can be predicted with a high degree of certainty.

After the conditionals with a noticeably epistemic nature, the pragmatic conditionals with the present tense in both clauses have the highest frequency. Interestingly, 7 out of 8 identified conditionals were accompanied by distinctive linguistic markers, making them markedly distinguishable from the inference course-of-the-event conditionals. It seems that the epistemic nature of them is preserved with these markers. Epistemic paraphrasing constructions (meaning, indicating, imply indicating, that means, we estimate), resultative conjunctions (then), and interrogative forms are widely expected in this group. Examples 9–19 show how these markers are widely used by writers. In these conditionals, the writers present a known situation (not general and customary) and give their viewpoints.

In addition to the conditionals featuring combinations of the simple present and modal verbs, a few others with different verb tenses were identified; however, their frequency was too low to allow for meaningful analysis. In our study, if-clauses using simple tenses in both the antecedent and consequent ranked second after the present–modal combination. However, Ferguson, Carter-Thomas and Rowley-Jolivet reported that this form was predominant in medical papers[8,10].

4.1.2. Hypothetical Conditionals in Research Articles

In our study, 17 hypothetical conditionals were found, and the neutral ones had the highest frequency. In these conditionals, the writers are unbiased about the occurrence or non-occurrence of an event and utter it in the form of conditionals with the simple present in the antecedent and 'will' or other auxiliaries in the consequent.

The simple present in antecedent and 'will' in consequent have proven to be prototypical verbs as they reached ten samples:

30.   *If the right-handed neutrino mass (MR) is below …, they will quickly be produced after inflation.*

The number of neutral conditions with other auxiliaries was comparatively low, and only three conditionals were found with 'can' or 'may' in precedent:

31.   *If leptogenesis takes place in the weak washout regime, the righthanded neutrinos may dominate*

32.   *The scale of leptogenesis can be brought lower if the reheating temperature is sufficiently low.*

Initially, they might be mixed up with pragmatic inference with the same form in verb tense; however, they are distinguishable by the relation between clauses. In these conditionals, there is a causal relation, and the consequent is possibly the consequential outcome of the protasis.

An insignificant number of conditionals (4 samples) were in the form of past/present in antecedent and 'would' in consequent:

33.   *Even if this accelerator could be realized, the low plasma density would lead to a higher bunch charge*

34.   *But if the photon's energy shift from its interactions in the medium is too different from the graviton's (speaking loosely), it would introduce an incoherence …*

What made these conditionals conspicuously different is the stronger stance that the writers take. In these conditionals, the writer doesn't simply elaborate a condition to outline the possible result but strives to give a claim and evidence it

or refute it in the main clause. This function was also pointed out by Ferguson in the medical corpus[10].

4.1.3. Course-of-Event Conditionals in Research Articles

The course-of-event conditionals were the least complex conditionals in terms of verb variation. These conditionals with the present tense in both clauses were primarily related to the experimental part of the research. They narrate an observation or an event resulting from a change in a particular practice. In many examples, they were general actions or statements whose authenticity had been confirmed before.

4.2. Conditionals in Editorials

In total, 21 pragmatic conditionals were identified, seven of which were conversational and the remainder logical. Before analyzing verb tense, it is important to clarify the concept of conversational conditionals as defined by Athanasiadou and Dirven[22]. As the term suggests, the interpretation of conversational conditionals depends on the context and on how the reader perceives the speech act. In the discourse domain, a subcategory of the conversational type, the relationship between the clauses functions as a performative act, which can be expressed either explicitly or implicitly in the antecedent and is limited to a specific state[20,22]. **Table 6** presents the types of conditionals along with their verb forms.

Table 6. Present-tense and modal variation in if-conditionals in editorials.

	Pragmatics	Hypothetical	Course-of-Events	Total
Present + present	8	0	1	9
Present + may, could, can	0	2	0	2
present + should/has to	5	0	0	5
Present + order	7	0	0	0
Present + will	2	1	0	3
Present/past + would	0	3	0	4
Past + past	0	1	1	2
Total	22	7	2	25

In our samples, every seven conversational discourses had in common the presence of the present tense in the antecedent and an explicit order in the consequent:

35.   *If you are not currently in the reviewer pool for PRST-PER, please send me a short note with your contact information and areas of expertise.*

36.   *If you receive a request to review a manuscript, remem-*

ber that the quality…

These examples generally include recommendations for potential editors interested in joining the team, as well as details about the manuscripts that authors should monitor during the submission process.

The rest of the conditionals were inference pragmatic, in which the conditionals with the present tense in both

clauses had the highest frequency, reaching eight samples. These conditionals fall in the inference subcategory as the writers induce situations that are likely to happen, and then, in the main clause, an inference is made that could be additional information or some guidelines.

37. *If the conclusion of the report is not to publish, the situation is trickier.*

38. *If the recommendation is to publish, in PRL or in another journal, additional information is useful to improve the manuscript.*

Finally, five conditionals were found with the present tense in the antecedent and the modals in the consequent, which had the third position in the pragmatic conditionals. The only used models were only 'must' and 'should', and the other models, like 'may' or 'could', were absent. This pattern evidences the more subjective and epistemic nature of this genre:

39. *If they conclude that a paper meets PRL standards, they must explain why.*

40. *We encourage joint submission of a Letter and an accompanying regular article in Physical Review. This should be considered if the additional material is of sufficient importance and completeness that ...*

The exploration of the samples revealed that these conditionals contain some regulations for the authors and editors. In the antecedent, the editors specify a case in reporting and, then, regulate its fulfillment. In example 32, the writer comes up with a particular standard and implies that its accomplishment depends on the writer's exact clarification. The high incidence of inference conditionals in editorials was also confirmed in a similar study conducted by Carter-Thomas and Rowley-Jolivet[8]. These conditionals, introduced as Refocusing conditionals, made up about 90 percent of conditionals in medical editorials.

The hypothetical and course-of-event conditions weren't as widely used as the pragmatics, counting as seven and two, respectively. Their limited use did not reveal a significant number of verb patterns, and consequently, we did not find them worthy of interpretation here.

4.3. Conditionals in Lectures Talks

The if-conditionals were highly dense in the lecture talks. This fact was also acknowledged in the study ex-

ploring multi-word sequences[30]. The authors found that dependent clauses, including condition adverbials, are considerably overrepresented in classroom teachings.

The high frequency of conditionals in our findings was mainly due to the prevalent use of pragmatic and course-of-events conditionals, which together accounted for nearly eighty percent of all conditionals and appeared in fewer verb variations compared to research articles. Similarly, Lastres-López showed that interpersonal conditional (epistemic + speech act) and ideational conditionals(content) make up for 99% of all conditionals in face-to-face conversations[25]. Among the pragmatic conditionals in lecture talks, two types were particularly frequent: inference and metacommunicative, with inference conditionals being the most common, occurring 33 times. A closer examination revealed that these conditionals primarily served to draw insights from mathematical operations. Since a significant portion of physics relies on numerical equations, when professors teach these operations, the antecedent typically presents a mathematical change, while the consequent discusses its possible implications.

Despite easily distinguishable epistemic markers of inference conditionals in research articles, this difference in lecture talks is not clear-cut, and these signals are rare. However, what made them conditionals different was their interactive nature. The pronouns 'you' and 'we' were integrated into 29 conditionals, making them more engaging. In terms of verb patterns, nearly 18 of them were in the present tense in both clauses, and 10 conditionals were in simple present or present progressive in antecedent and modal in consequent. The progressive aspect is used when the lectures imply a mathematical change at the same time. The variation of other inference conditionals could not make up for a particular pattern. A significantly lower use of modal verbs and a tendency to appear in structurally simpler forms are also observed in interpersonal (pragmatic) conditionals[25].

Another subcategory of pragmatic conditionals frequently observed in lecture talks is metacommunicative conditionals. In these conditionals, the if-clause softens the antecedent and is used to convey politeness[22,23]. The dependency between the clauses is minimal, and in some cases, the if-clause can even be omitted without altering the meaning.

These conditionals were absent in the research arti-

cles and editorials, reaching 30 incidences in lecture talks. Having analyzed them, we found that 27 of the metacommunicative conditionals were the ones in which the professors aimed to get their audience engaged or draw their attention to what was being taught. In these conditionals, expressions like 'if you see', 'if you consider', 'if you take a look', or 'if you recall' were used abundantly. Kaltenböck-Keizer introduced them as interpersonal conditions, which have a non-conditional nature and function as modifiers of the illocution or communicated content[31]. Warchal, who studies interpersonal conditionals in research articles, called these utterances 'conventional expressions of politeness' in which the writer seeks the reader's permission[12]. Lastres-López found that all conditionals serving politeness functions in conversation are engagement-oriented, targeting the addressee rather than expressing the speaker's attitudes[25]. However, the study most comparable to lecture talk register is Biber and colleagues' analysis of conditional adverbials in classroom teaching[30]. In addition to the epistemic conditionals they discussed, they also found conditionals using second-person pronouns that aim to engage students.

> "*Topic introducing bundles with second person pronouns invite student participation…*"[30]

Evidently, the conditionals in our study serve this function. The speakers aim to encourage the audience to engage and make the lecture more interactive.

Below, some examples of these conditionals are presented:

41. *Here if you look at, I will be putting my angle.*

42. *If you consider, it is from my suction side to the pressure side, okay.*

43. *Why neutrinos are important? Because, if you remember β^- decay or β^+ decay, neutrinos are very difficult to detect.*

44. *Now, if you see sun's nearest stellar neighbor, it is about four light years away*

What these conditionals have in common is the use of the present simple in the subordinate clause. More than two-thirds have also been present in the consequent (18 out of 27 there).

In the rest of them, the if-clause was found as a comment left on the main clause, signaling that what is uttered here may not be sufficient to lead toward the understanding[12,22].

45. *So, in other words that could be 2,if I am talking about a particle that is otherwise in three dimension, but lives on a surface.*

46. *I can simply rewrite this as T-V if I want.*

Following pragmatic conditionals, course-of-event conditionals ranked second, with 36 occurrences. While pragmatic inferences were used to explore different aspects of a topic, lecturers employed course-of-event conditionals to discuss facts that are already proven or accepted.

Finally, nine conditionals were classified as hypothetical, representing a comparatively low frequency. These typically feature the simple present in the antecedent and *will* in the consequent.

5. Conclusions

Language choices are shaped through prolonged practice among members of a community[32]. Examining the natural occurrence of these conventions allows us to understand which linguistic variants are used in each register. Building on this tradition, we conducted a quantitative study of conditionals in the field of physics, with attention to their qualitative features. In our research, we relied on Athanasiadou and Dirven's taxonomy, which is both detailed and well-established[17].

The initial examination revealed that pragmatic conditionals stand out, showing a notable gap from other types. Upon closer analysis, they proved to be versatile, serving different functions across categories. Inference conditionals—referred to as epistemic conditionals by Sweetser—were commonly found throughout the corpus[20]. In these conditionals, the antecedent introduces a familiar situation or assumption, while the consequent presents a deduction or plausible speculation. Two dominant verb forms were observed in both research articles and lecture talks: simple present in both clauses, and simple present in the antecedent with a modal in the consequent. In research articles, inference conditionals often appeared alongside modal verbs, epistemic discourse markers, epistemic paraphrasing, or resultative conjunctions. They are in fact hedges which mitigate the commitment of the writer[33].

The occurrence of discourse markers in inference conditionals of lecture talks was less prominent than in research

articles, yet they were more noticeable when combined with the pronouns 'you' and 'we'. Beyond inference pragmatics, two other pragmatic types were also significantly represented in our corpus: metacommunicative and discourse conditionals. Metacommunicative conditionals appeared exclusively in lecture talks, used by lecturers to engage their audience and typically incorporating the second-person pronoun. The use of 'you' to promote active participation has also been documented in studies of classroom discourse [34,35]. These conditionals generally follow the pattern of simple present in both clauses. Discourse conditionals, on the other hand, were found only in editorials, where they convey recommendations for potential authors in specific situations. In these cases, the consequent expresses an instruction or piece of advice, often using modals such as 'should' or 'have to'.

The different types of pragmatic conditionals discussed account for nearly half of all conditionals. What sets them apart from course-of-events or hypothetical conditionals is their interpersonal nature. Their significance lies in enabling academic writers to establish a consensus with the discourse community and to gain recognition for their claims [12]. The high prevalence of these interpersonal conditionals is understandable when considering how knowledge is constructed in the field of physics.

A significant portion of findings cannot be obtained directly in laboratories and largely depends on numerical equations or thought experiments. Even many practically feasible experiments must be conducted under simulated conditions and cannot be performed in genuine settings. While the facts support the reasoning behind the findings, the uncertainty of conditions prevents fully rigorous results, prompting scholars to make approximate interpretations. Inference conditionals enable researchers to approach results thoughtfully and with less subjectivity. The other two types of pragmatic conditionals serve a similar purpose. Discourse conditionals reduce commitment to a particular state [20], while metacommunicative conditionals indicate that the truth of a statement is not sufficiently established to yield a specific outcome [12]. In this way, pragmatic conditionals address the communicative and reasoning needs of scholars in physics.

In addition to pragmatic conditionals, numerous course-of-events conditionals appeared in both research articles and lecture talks. These conditionals represent facts or well-established theories in physics, exhibit minimal variation

in verb patterns, and are primarily expressed in the present tense in both clauses. The only genre with a notable number of hypothetical conditionals was research articles. Their frequency was slightly lower than that of course-of-events conditionals, and their prototypical form features the present tense in the antecedent and the modal 'will' in the consequent. However, this verb pattern is not unique to hypothetical conditionals and is also common in other types. What distinguishes hypothetical conditionals is the clausal relationship: the assumption in the antecedent gives rise to a result, whereas in neutral conditionals, the researcher remains neutral regarding the occurrence or non-occurrence of the event in the consequent. Other types of conditionals, such as second conditionals, were extremely rare.

All things considered, even though the verb pattern in conditionals was not so varied, their functions were far beyond what is attributed to them. In other words, it happened a lot that a singular form manifested in different uses. Consequently, it seems that focusing on form only as a classified frame would be ineffective in practice, as there is no accurate one-to-one relation between the form and function.

5.1. Implications

This study has implications for future research and for physics educators. First, any analysis of if-conditionals needs to involve a precise examination of the context and the relationship between clauses. The initial aim of this study was to offer physics students a more stable and detailed taxonomy of conditionals, enriched with nuanced information about the verb forms associated with each category. However, despite the versatility of their functions, if-conditionals were found to appear in relatively uniform structures, showing limited variation in form. For example, the single pattern of a simple present in the antecedent and a modal in the consequent proved capable of expressing factual, hypothetical, or pragmatic meanings depending on the contextual setting. Our findings bear resemblance to what Comrie states about the conditionals. He avoided putting them in different categories, but assumed them on the continuum whose factuality or hypothetically was determined by the context [19]. Therefore, it is recommended to investigate these structures within the settings in which they occur, not in isolation. Secondly, it underscores the importance of moving beyond rigid

classifications and recognizing the versatile functions of if-conditionals. Teaching of conditionals in ESP classes needs to be contextualized, and explicit instruction is required to draw the learners' attention to their functions. Lastly but not least, our study highlighted the role of inference conditionals in arguing and logical deduction in physics discourse. Although these conditionals have been described with labels of epistemic [20] or refocusing [8], this study dusted them and emphasized their paramount role in approaching the conclusion more cautiously. Here, it would be harmless to mention an interesting if-conditional in our data, stated by a professor in the quantum mechanics class:

47. *If you feel that it is not obvious how I got from this step to the next step, then you should not switch off and pretend that you have understood.*

Apart from facts like -if we drop an apple, it falls due to gravity- the knowledge in Physics is largely constructed through simulation and theorizing, and scholars need to frame their argument or inference in a way that is open to further evidence. Schrödinger's cat in quantum mechanics states that until you observe the cat, it's both alive and dead at the same time. Similarly, a deduction from an equation, experiment, or analysis could be simultaneously right or wrong, and inference conditionals convey this inherent uncertainty.

5.2. Limitations

This study aimed to illustrate the real-world use of conditionals, moving beyond the stereotypical structures typically associated with them. However, it acknowledges certain limitations and cannot be considered without flaws. First, we focused exclusively on if-conditionals, leaving other structures that convey conditional meaning unexplored. Including these other types would make the study more complex, but it is advisable to examine them separately in terms of form and meaning. Another aspect concerns the order of antecedent and consequent. Although rare, we did encounter instances in which the antecedent follows the consequent; addressing this feature could help determine the genre or the constraints influencing the initial position of the main clause.

All in all, academic English is as varied as all the subjects and disciplines communicated through the English language. This diversity, consequently, promotes considerable potential for investigation and study.

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The author declares that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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