

La science : des certitudes ou des hypothèses ?

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Comment sont produits les résultats scientifiques ?

- L'objet de la recherche scientifique : est-ce la **vérité** ou l'**inconnu** ?
- La science travaille-t-elle uniquement avec des **faits avérés**, ou bien des **incertitudes** ?

Comment sont produits les résultats scientifiques ?

- En réalité, les articles scientifiques ne contiennent pas que des faits solides :
 - Ils sont remplis d'**hypotheses**, de **questions ouvertes**, d'**incertitudes** et de **limites**
- Pourquoi ? Parce que la science avance en explorant l'**inconnu**. Son objectif est de repousser les limites de la connaissance

HUMAN IMMUNOLOGY

Fibroblastic reticular cells form reactive myeloid cell niches in human lymph nodes

Mechthild Lütge^{1†‡}, Lisa Kurz^{1†}, Yves Stanossek^{1,2}, Samuel Meili^{1,2}, Hung-Wei Cheng¹, Angelina De Martin¹, Joshua Brandstadter³, Ivan Maillard^{3,4}, Mark D. Robinson⁵, Sandro J. Stoeckli², Natalia B. Pikor^{1,6}, Lucas Onder¹, Burkhard Ludewig^{1,7,8*}

Lymph nodes play a key role in maintaining fluid balance in homeostatic and inflamed tissues and provide a niche environment for optimal immune cell positioning and interaction. Here, we used single-spatial transcriptomic analyses in combination with high-resolution imaging to molecularly define and finally characterize niche-forming cells that control inflammation-driven remodeling in human lymph nodes. Fibroblastic reticular cells responded to inflammatory perturbation with activation and expansion of perivascular environments. Inflammation-induced adaptation of lymph node infrastructure and topography included expansion of peptidase inhibitor 16 (PI16)-expressing reticular cell (PI16⁺ RC) networks that envelop the perivascular system. Interactome analyses indicated that macrophage-derived oncostatin M directs PI16⁺ RC function in inflamed lymph nodes and thereby promotes immune cell aggregation in the perivascular space. In addition, these data demonstrate that the inflammatory remodeling of human lymph nodes results in the formation of reactive myeloid cell niches by PI16⁺ RCs.

INTRODUCTION

The balance between inflammation and tissue homeostasis is critical for the survival of multicellular organisms (1). Activation and regulation of immune responses in mammals is controlled in secondary lymphoid organs that surveil bodily and external fluids for pathogen-derived, potentially harmful antigens and inflammatory compounds (2–4). To provide immune surveillance of internal organs and body surfaces, lymph nodes are strategically located at key intersections of the lymphatic and blood vascular systems (3, 5). Although the distribution of lymph nodes in mice shows little variation (6), the abundance of lymph nodes draining human tissues is highly variable (7). Moreover, de novo formation of lymph nodes in human glandular tissues, for example, in response to viral infection (8), contributes to the versatility of immunological infrastructures in humans. Repeated exposure to inflammatory stimuli, including

subsequent topographical remodeling, remained largely elusive.

Control and regulation of immune differentiation in lymph nodes are sets that generate and dynamically (5, 18, 19). The major FRC subsets include zone reticular cells (TRCs) located in the cortex, medullary reticular cells (BRCs) underpinning follicular dendritic cells (FDCs) and medullary reticular cells (MedRCs) and interfollicular reticular cells (IFRCs), which form fibroblastic networks (17, 21). Perivascular reticular cells form immune cell niches around blood vessels and interact with the reticular cell network (3, 22). Fibroblasts expressing perivascular fibroblasts expressing peptidase

Article

temperatures²¹. (4) These declines could be exacerbated by increased competition with colonizing species originating from Low Arctic and boreal latitudes^{22,23} or by local species becoming better competitors under warmer conditions⁴. Because these pathways may be acting in concert, it is possible, and indeed likely, that richness increases and decreases could occur simultaneously, resulting in no net changes in richness. Yet, the effects of these different pathways on current and future Arctic plant diversity trends remain poorly understood. We address this knowledge gap by quantifying the direction and magnitude of Arctic vascular plant diversity change over time at the local level (α diversity) and temporal turnover in species composition (β diversity). We also investigate which geographical, climatic and biotic drivers are related to different aspects of diversity change to understand trends across the Arctic.

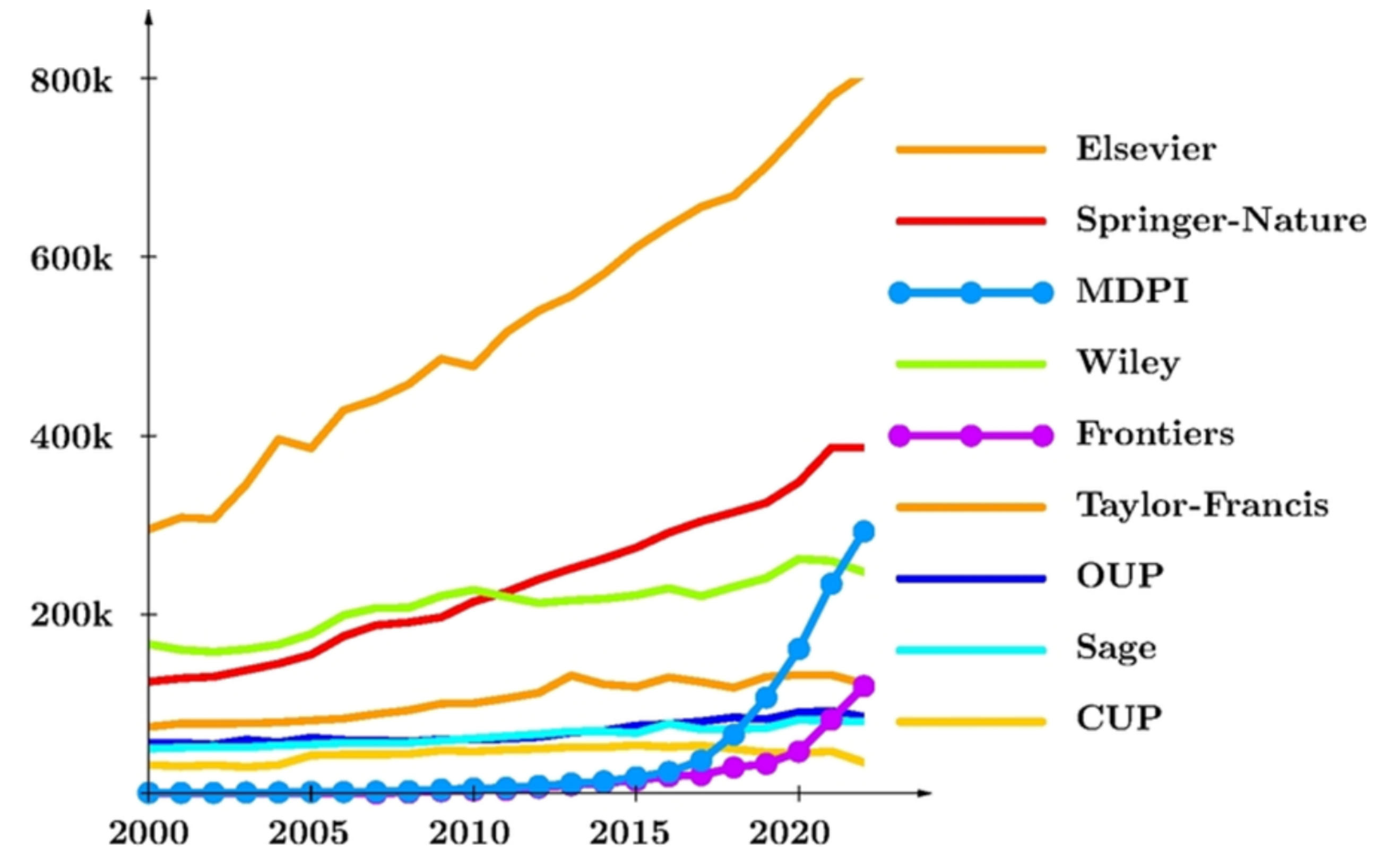
Apart from evolutionary history and biogeography, species richness patterns at large scales are broadly driven by climatic gradients²⁴. Many taxa have a latitudinal gradient in diversity, in which species richness is greater at lower latitudes, which are generally warmer^{25,26}. Therefore, Arctic vascular plant richness is expected to increase over time as rapid warming^{1,27} leads to new, warmer thermal niches for warm-adapted species at northern latitudes. This expectation is further supported by observed increases in vascular plant species richness with warming across European mountain tops^{28,29}, where elevational gradients mirror Arctic latitudinal climatic and richness gradients³⁰. Spatially, we would expect plant richness to increase at warmer, lower Arctic latitudes because of the potential influx from the species-rich boreal forest (borealization)^{31,32} and because the dissimilarity between Low Arctic and boreal flora is more pronounced than the dissimilarity between High and Low Arctic flora³³. Overall, we expect richness increases where more warming has occurred and at lower latitudes closer to the boreal zone.

par Alan Turing en 1950⁴ était construit autour d'un "test" assimilable, en fait, à ces Thought Experiments qui vont traverser l'histoire de l'I.A. J'appellerai "TEX" ce type d'expérimentation et d'argumentation en I.A., dans la psychologie cognitive ou la philosophie des états mentaux, car je crois opportun d'indiquer ainsi que la méthode, dont le vocable a été emprunté à la Physique, a subi une transformation profonde lors de son assimilation par les sciences humaines.

L'EXPERIENCE IMAGINAIRE
ORIGINE ET BON USAGE

C'est en effet au physicien Ernst Mach que l'on doit l'expression de "Gedankenexperiment" (litt. "expérience de pensée") pour désigner une méthode qui plus tard sera au cœur de la polémique entre Niels Bohr et Albert Einstein, méthode qui n'avait pas attendu d'être nommée avant d'être mise en œuvre. Alexandre Koyré a montré⁵ que si Galilée avait réellement effectué la fameuse expérience de Pise que tant d'historiens lui prêtent, celle-ci eût tourné à sa confusion : l'expérience était en fait imaginaire...

Evolution de nombre de publications scientifique



Pier, B., & Romary, L. (2024, December 4). *Excessive growth in the number of scientific publications*. Ouvrir la Science. <https://www.ouvrirlascience.fr/excessive-growth-in-the-number-of-scientific-publications/>

Où se trouve l'incertitude ?

- « Nos résultats suggèrent que... »
- « Ces observations pourraient être expliquées par... »
- « Il est possible que ce phénomène soit dû à ...»
- « Il est probable que cette tendance soit liée à ... »
- « Les données semblent indiquer que... »
- « Cependant, ces résultats doivent être confirmés par des études futures ... »

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- « Nos résultats **suggèrent que**... »
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1 The variability of strategic voting over longer periods of time **is yet completely unexplored**.

Explicit SU

2 **If** there are any violations, subsequent inferential procedures **may be invalid**, and **if so**, the conclusions **would be faulty**.

Conditional

Modality

Conditional

Modality

Scannez moi !



Kusuma Ningrum, P., Gutehrle, N., & Atanassova, I. (2025). *Etudier l'incertitude dans les articles scientifiques : mise en perspective d'une méthode linguistique*. Revue des Nouvelles Technologies de l'Information, 41. <https://hal.science/hal-04916352>

Comment évolue l'incertitude dans le temps ?

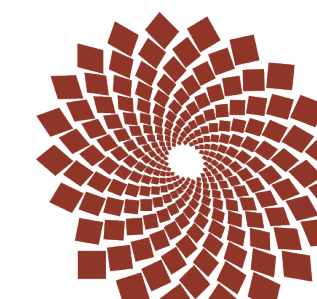
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<https://project-inscim.github.io/>

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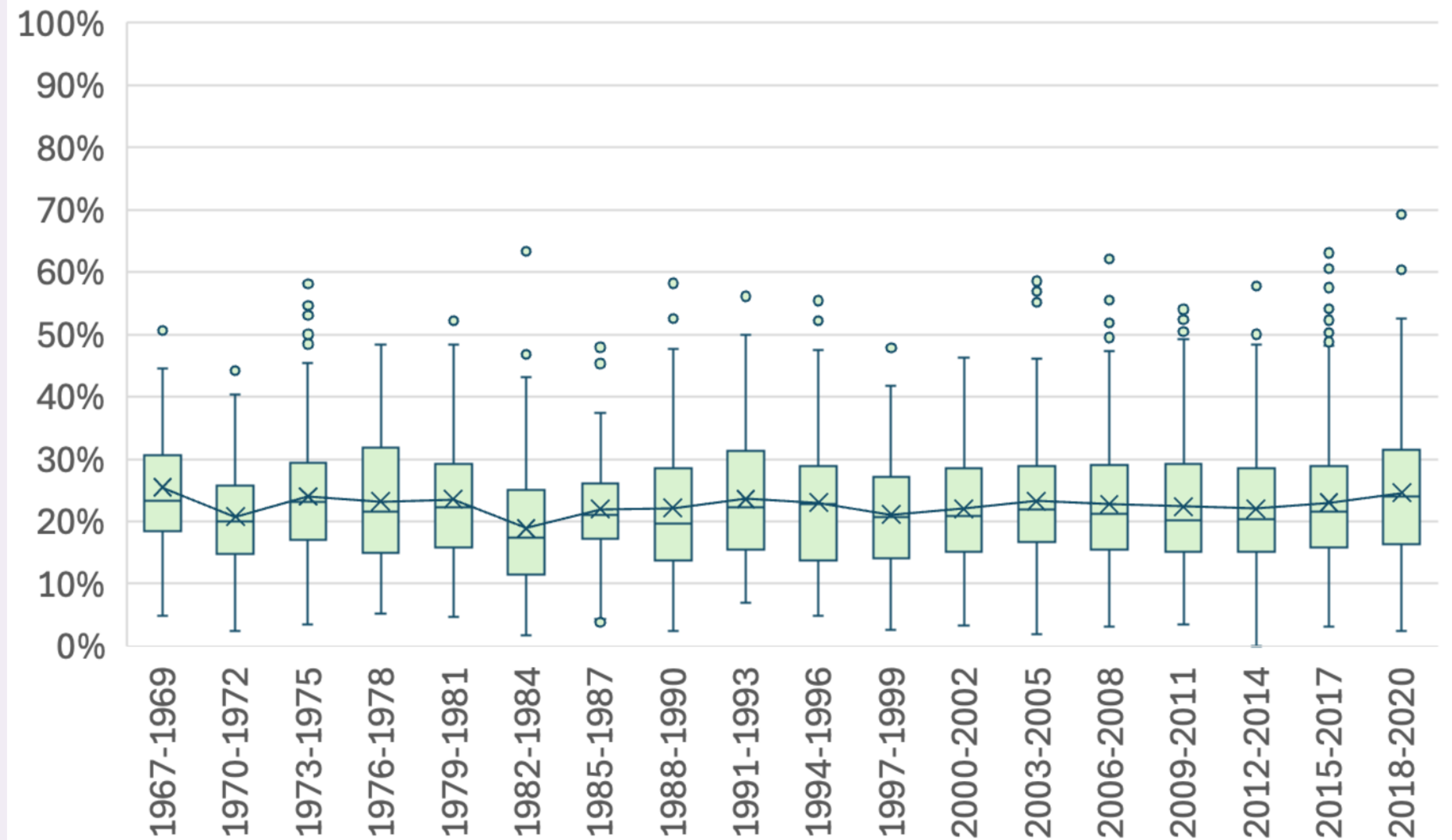
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Comment évolue l'incertitude dans le temps ?



Atanassova, I., Kusuma Ningrum, P., Gutehrlé, N., Larreau, F., & Malaterre, C. (2025). *Is There Life on Mars ? Studying the Context of Uncertainty in Astrobiology [A paraître]*. 20th International Society of Scientometrics and Informetrics Conference 2025, 13.

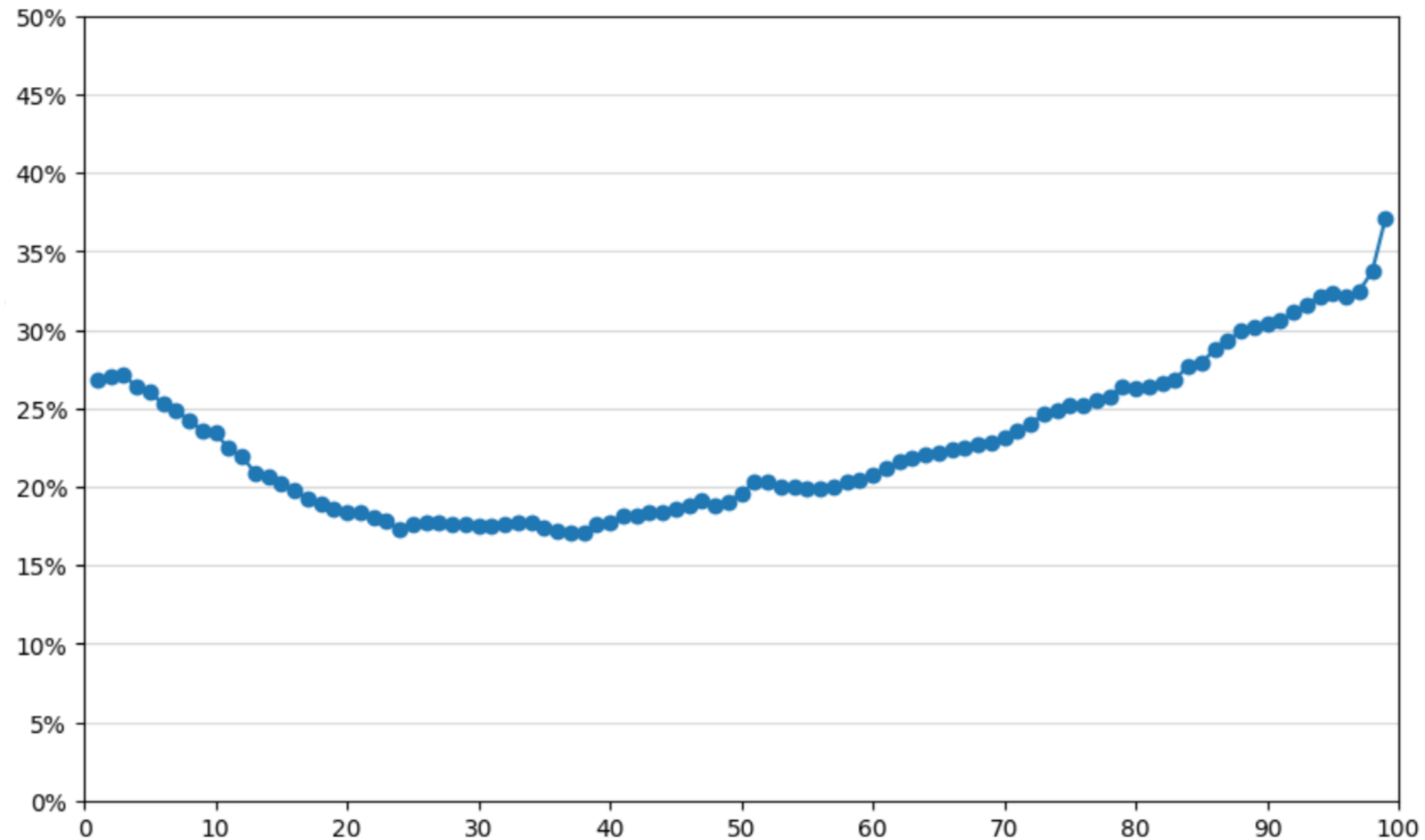
Comment évolue l'incertitude dans l'article ?

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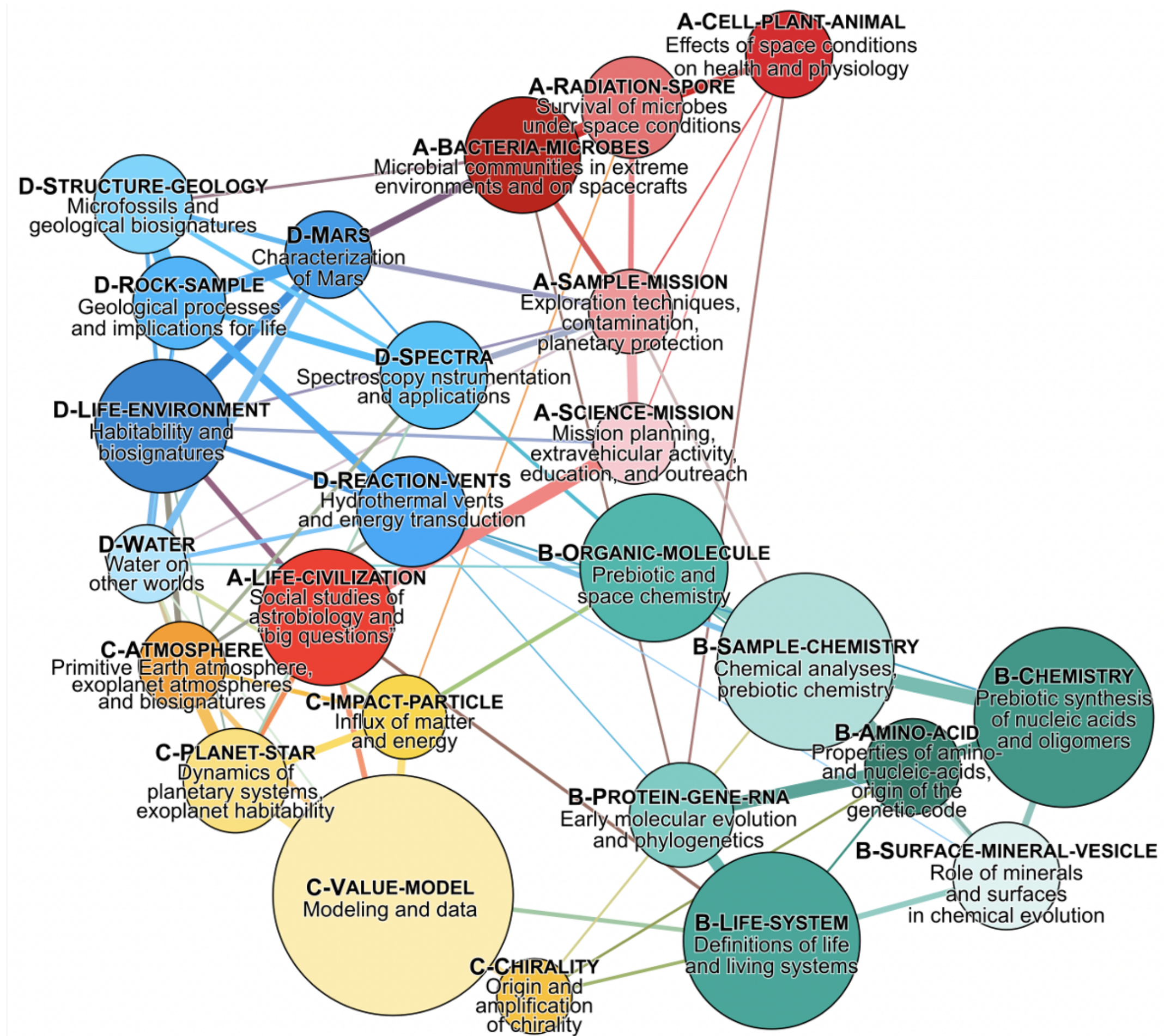


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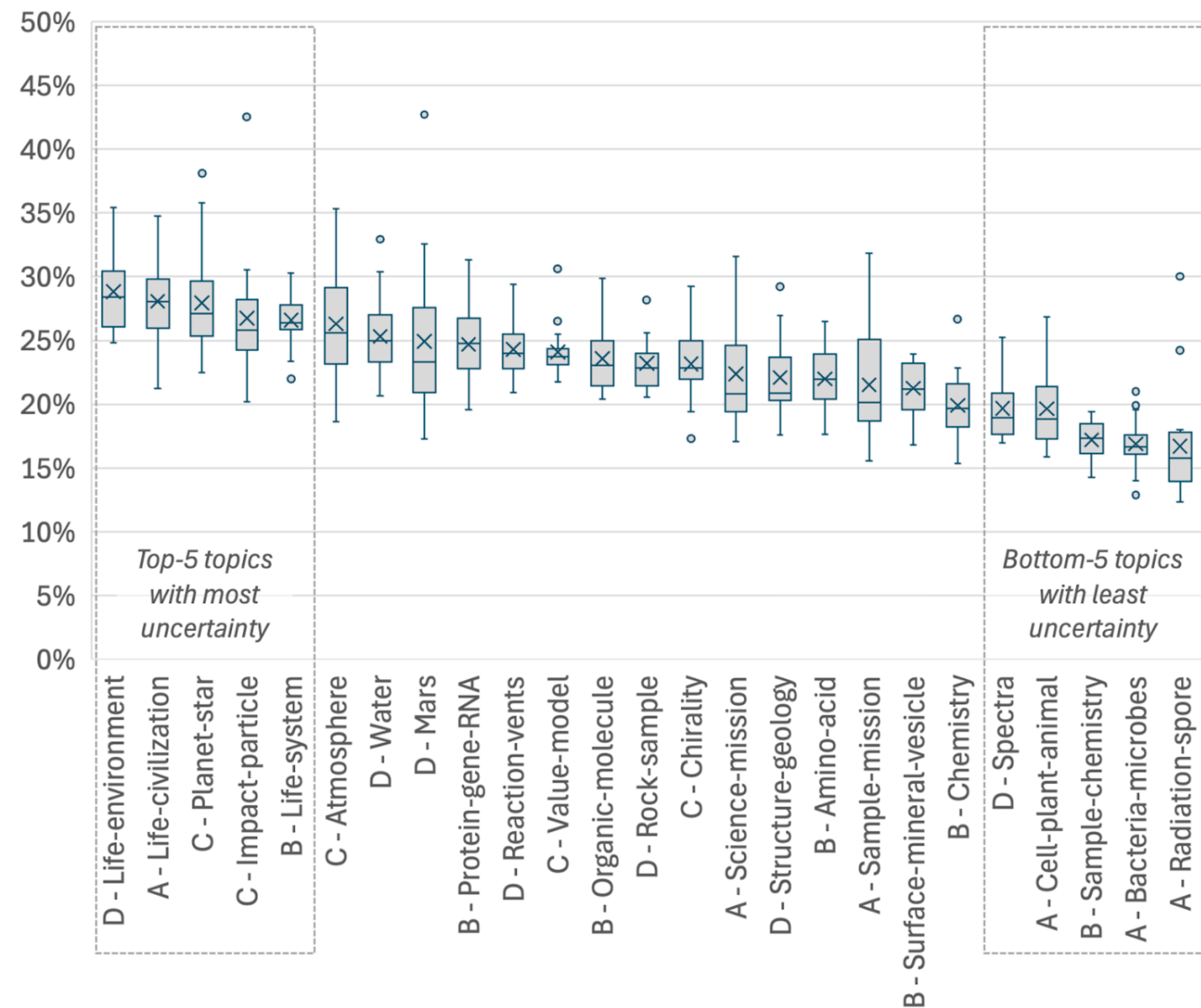
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Sur quoi porte l'incertitude ?



Malaterre, C. & Lareau, F. (2023). *The Emergence of Astrobiology: A Topic-Modeling Perspective*. *Astrobiology*, 23 (5), 496-512. <https://doi.org/10.1089/ast.2022.0122>

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Atanassova, I., Kusuma Ningrum, P., Gutehrlé, N., Larreau, F., & Malaterre, C. (2025). *Is There Life on Mars ? Studying the Context of Uncertainty in Astrobiology* [A paraître]. 20th International Society of Scientometrics and Informetrics Conference 2025, 13.

Sur quoi
porte
l'incer-
titude ?

Topics with the highest relative uncertainty					Top 5 % of articles	All articles
D-Life-environment	A-Life-civilization	C-Planet-star	C-Impact-particle	B-Life-system		
life (0.357)	life (0.241)	planet (0.352)	impact (0.200)	life (0.199)	life (0.253)	life (0.151)
Earth (0.216)	planet (0.122)	star (0.212)	Earth (0.178)	system (0.188)	Earth (0.164)	Earth (0.116)
environment (0.161)	Earth (0.116)	Earth (0.153)	life (0.130)	molecule (0.122)	planet (0.136)	surface (0.107)
planet (0.160)	civilization (0.110)	system (0.152)	time (0.127)	evolution (0.119)	surface (0.123)	planet (0.101)
Mars (0.139)	time (0.106)	life (0.132)	event (0.122)	process (0.109)	time (0.116)	
surface (0.129)		mass (0.121)	planet (0.109)		water (0.112)	
water (0.111)		atmosphere (0.113)				
condition (0.109)		time (0.105)				
		water (0.103)				

Topics with the lowest relative uncertainty					Bottom 5 % of articles	All articles
D-Spectra	A-Cell-plant-animal	B-Sample-chemistry	A-Bacteria-microbes	A-Radiation-spore		
spectrum (0.224)	cell (0.183)	acid (0.224)	sample (0.194)	sample (0.224)	sample (0.141)	no terms
sample (0.180)	experiment (0.104)	sample (0.200)	cell (0.110)	radiation (0.177)		
Raman (0.153)	study (0.103)	experiment (0.140)		cell (0.170)		
band (0.136)		water (0.111)		condition (0.146)		
surface (0.100)		solution (0.107)		space (0.142)		
		temperature (0.106)		spore (0.142)		
		reaction (0.101)		experiment (0.139)		
		compound (0.101)		exposure (0.134)		
				temperature (0.107)		

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- L'**incertitude** fait partie intégrante du processus scientifique
- Permet à la recherche d'avancer et de se corriger au fil du temps

La science : des certitudes ou des hypothèses ?

- Notre objectif est :
 - de **cartographier** les **incertitudes** dans différentes disciplines
 - produire des algorithmes qui **lisent** les articles scientifiques et **trouvent** les incertitudes
 - connaître les questions qui restent **sans réponse**, et trouver les **futurs sujets de recherche**

Merci de votre attention !

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