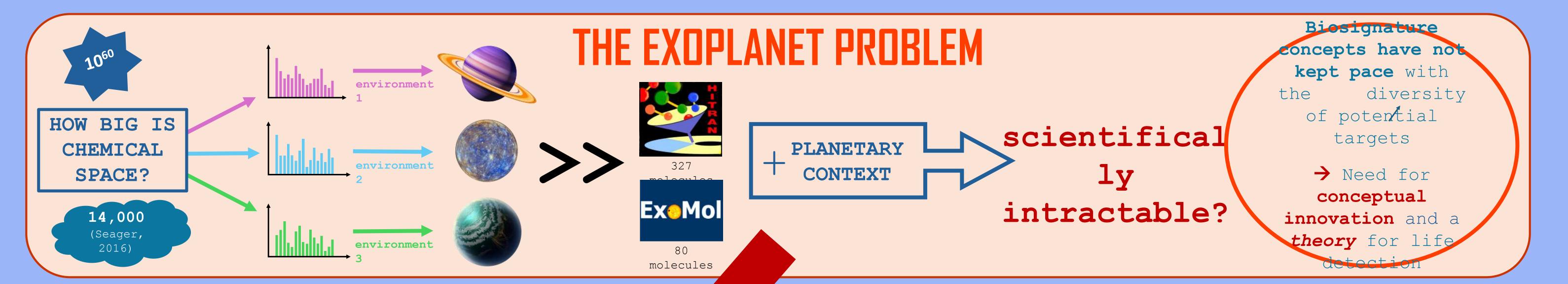


ASSEMBLY OF PLANETARY ATMOSPHERES: Towards a New Agnostic Framework for **Data Interpretation & Life Detection** Estelle M. Janin¹, Sara I. Walker^{1,2}

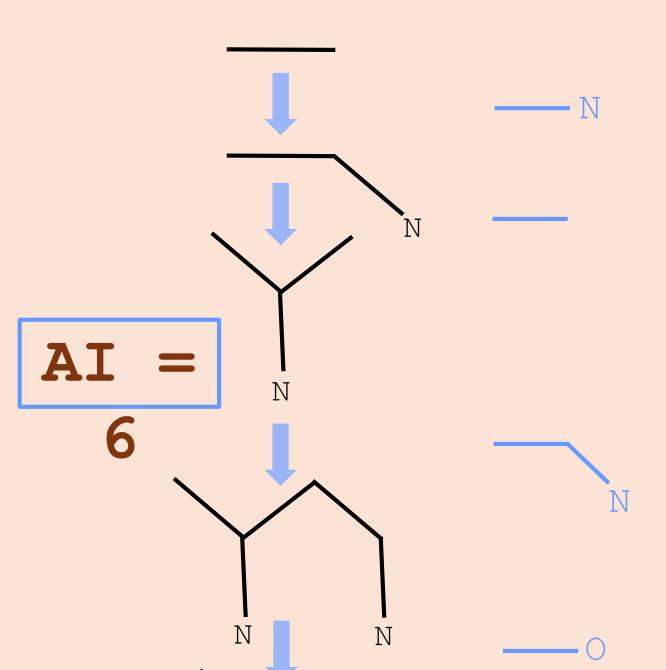


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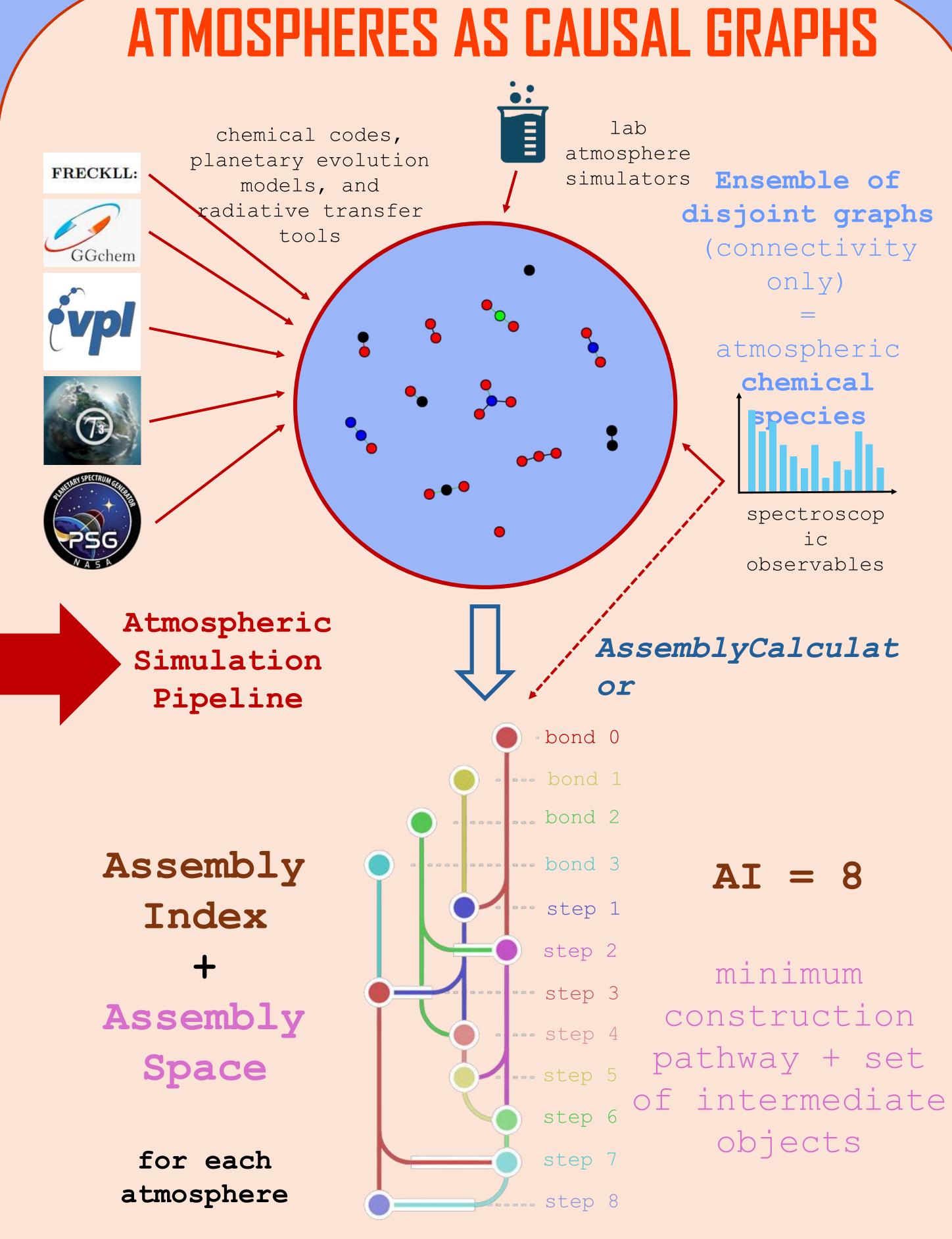
ASSEMBLY THEORY

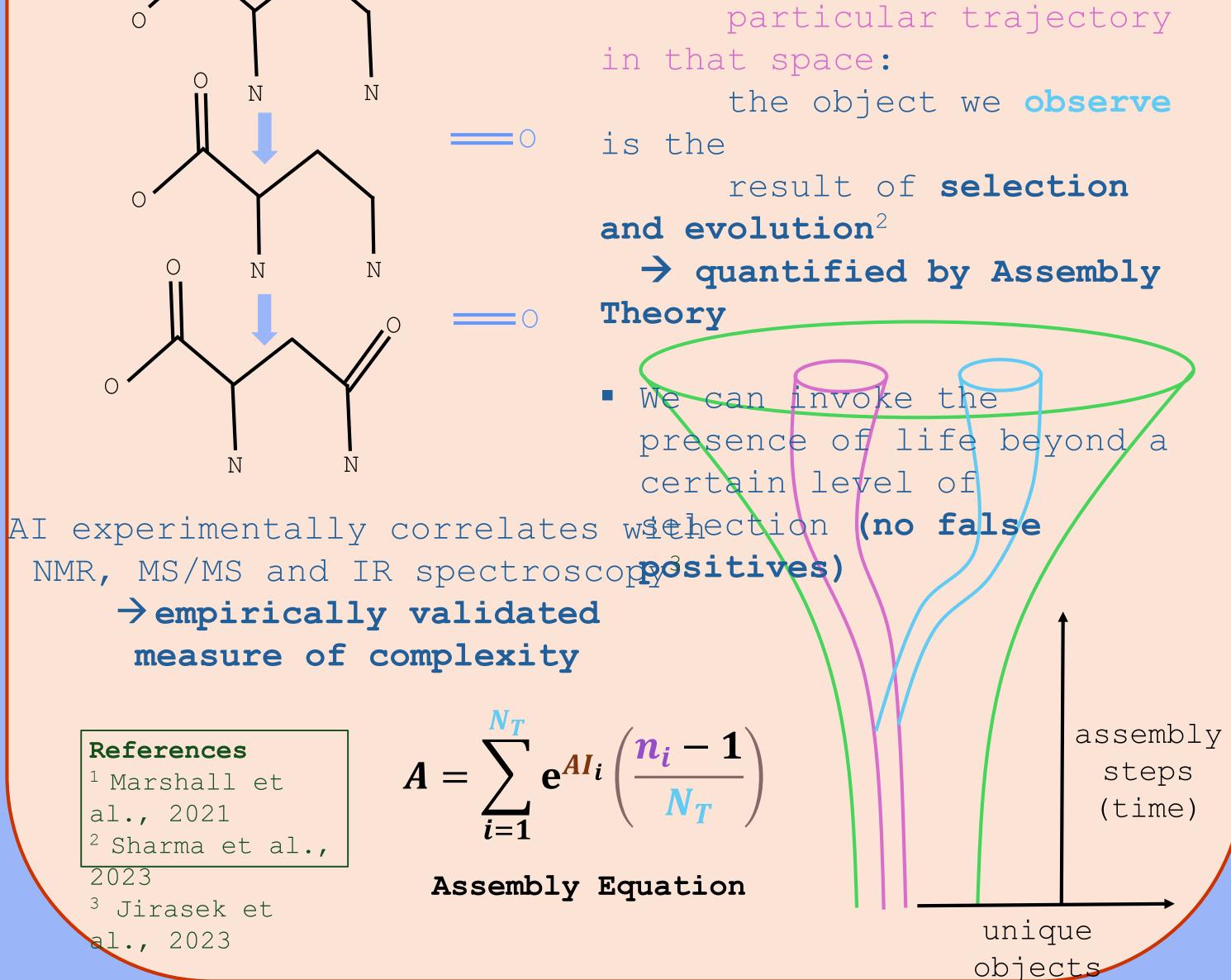
School of Earth ai



Life produces complex objects in abundance:

- ✓ Assembly Index: minimum number of steps required to recursively build the object
- ✓ Copy Number: number of identical copies of the object • On Earth, chemical compounds with AI > 15are **all biogenic**¹
- A system explores the space of possibilities and follows a





- *** Kinetic-independent, detection-driven** (≠ chemical abundance characterization), agnostically comparable across *all* planets
- Describe the relatedness of planetary atmospheres based on the structure of the causal relationships bet men molecules and how easy (abiotic) or hard c) it is to co-construct them all

TOWARDS OBSERVATIONAL VALIDATION

Preliminary Results: Solar System atmospheres Assembly Index 50 40 <u>ک</u>م 30 Asseml 50 10

(> 1 ppb species, no condensates)

theoretical investigation $p(A|O) \sim p(O|A)p(A)$ How well can we **reconstruct the**

Mission-oriented

Assembly Space given (limited) spectroscopic data?

How well can we predict the presence of undetected species compared to conventional

retrieval pipelines?

DETECT PLANETARY-SCALE SELECTION

> Understand how chemical complexity gets generated at a planetary scale and how it translates into the atmosphere

> Determine the minimum amount of selection needed to construct an atmosphere as a way to classify planets according to how alive they are

Efforts towards a testable life detection framework with a better