

Logic of Discovery or Psychology of Research?

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Theories and Data



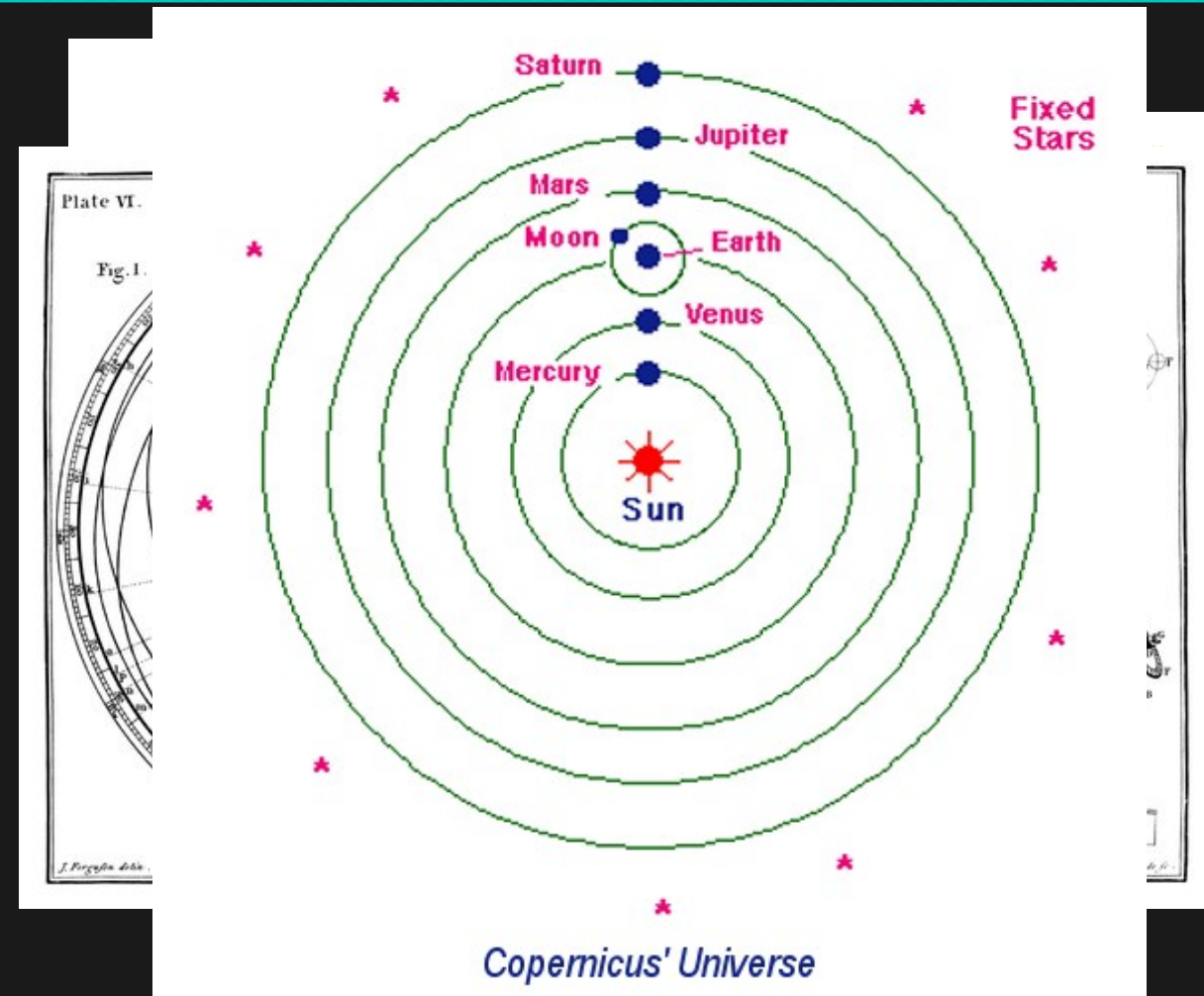


Normal vs Revolutionary Science

- Normal science
 - Science conducted under a unified **paradigm**
 - E.g., a schema of established methods, background assumptions and criteria for success of hypothesis testing
 - Majority of scientific enterprise
 - Incremental progress
- Revolutionary science
 - Challenges (an) existing paradigm(s)
 - New paradigm is **incommensurable** with its competitors
 - Rare occurrence
 - Discontinuous progress

Copernican Revolution

1. Ptolemaic model prevailed as an explanation for motion of the heavens (**Normal science**)
2. Despite more and more accurate astronomical measurements, increasingly intractable combinations of epicycles and deferents needed to model motions (**Crisis**)
3. Copernicus noticed that *the math was simpler* by placing the sun at the center (**Revolutionary science**)
 - Called the theory, not the data, into question
 - Empirically no better than Ptolemaic model
 - Rejected Aristotelian epistemology and cosmology as a whole





Popper Problems

1. Popper points to revolutionary science as the (sole) source of growth in a field
 2. Popper says falsifiability is the hallmark of a science
 - E.g., astrology is not a science because it is not falsifiable
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1. Kuhn says that mature science cannot exist without a paradigm (normal science)
 - Astrology was regularly falsified, but astrology is not a science because it cannot organize itself to systematically solve problems
 2. Scientific revolutions begin even in the absence of any evidence for them
 - Falsification *is what follows* from a new paradigm having replaced an old paradigm: it itself is not necessary to inaugurate a new paradigm
 - E.g. Copernicus, Einstein, Bohr

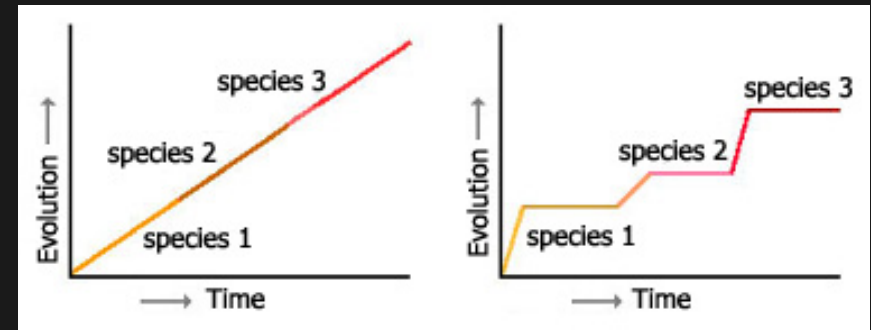


But...

- Psychological or sociological criteria for evaluating goodness of a theory that are non-syntactic and meta-scientific
 - Balance of convergence (plausibility) and multi-aptness (generalization)?
- If not falsifiability, how does crisis play a role in inaugurating a revolution?
- Revolution at different 'levels'?
 - E.g. within methodology, within a specific problem, etc...
 - Do falsifiability/crisis still play the same roles here?

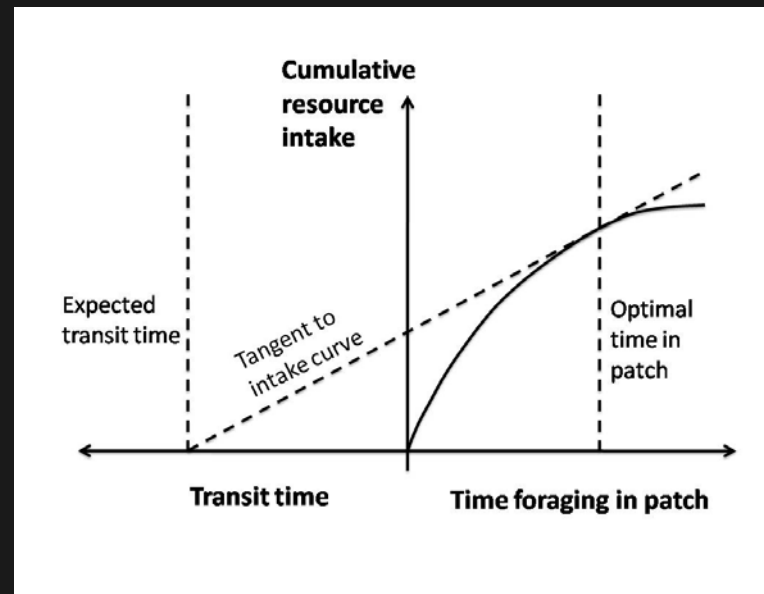
A Debate at Multiple Levels?

- Biological: gradualism vs. punctuated equilibrium
- Psychological: insight, perceptual shift
- Ideological: political revolution



How could crisis play a role in inaugurating a revolution?

- Paradigm shift can be conceptualized as an exploitation/exploration decision
 - When is it optimal for a paradigm shift to occur?
 - Marginal Value Theorem: when the instantaneous 'reward' falls below the long-term average reward



Questions?

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Unknown grad student doing revolutionary science (colorized).