

- Some Responses to Popper’s “Falsificationism”

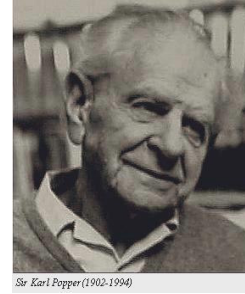
### THOMAS KUHN (Optional Reading<sup>1</sup>)



“Progress in Science is mostly a **puzzle**-solving activity.”

-Thomas Kuhn

vs.



Sir Karl Popper (1902-1994)

“Progress in Science is mostly a **problem**-solving activity.”

-Sir Karl Popper

“It is important to notice that when I describe the scientist as a **puzzle-solver** and Sir Karl describes him as a **problem-solver** the similarity our terms disguises a fundamental divergence. Sir Karl writes...’[O]ur expectations, and thus our theories, may precede, historically, even our problems. *Yet science starts only with problems* Problems crop up...when our theories involve us in difficulties, in contradictions.’ I [on the other hand] use the term ‘puzzle’ in order to emphasize that the difficulties which *ordinarily* confront even the very best scientists are...challenges only to his ingenuity. **He is in difficulty, not current theory. My point is almost the converse of Sir Karl’s.**”

“Logic of Discovery or Psychology of Research?”  
CC1998 (n. 2, pp. 17-18)

→ Primary complaint:

When Popper describes science fundamentally as a testing-process against a system of statements/hypotheses/theories...he too easily lumps such notions together. Rendering the notions less ambiguous shows that Popper’s notions “miss [ ] just that

<sup>1</sup> We’ll be reading quite a bit of Kuhn’s ideas later in the course. This article just touches on some of his most essential notions.

characteristic of scientific practice which...[basically] distinguishes the sciences from other creative pursuits.”

(-ibid., CC1998, p.11)

- **“Normal” Science versus Extraordinary (or Revolutionary Science)<sup>2</sup>**

“[W]hen engaged with a **normal** research problem, the scientist must *premise* current theory as the rules of his game. His [or her] object is to solve a **puzzle**, preferably one at which others have failed, and **current theory is required to define that puzzle** and to **guarantee** that that, given sufficient brilliance, it can be solved.”

*Examples are plain enough to come by (both from current and from defunct theories)*

**-(Current): (Just one from an innumerable list)** EM interaction with acoustics...the basis of RASS (radio-acoustic sensing systems): How to derive the values of the scattering cross-section coefficients of EM waves bouncing off acoustic pulses?<sup>3</sup> **Think of other examples from whatever area of science you may be studying**

**-(Defunct)** (mentioned in footnote , p.13) (Lorenz-Fitzgerald contraction/ T Brahe’s proposals, etc.)

- **A ‘puzzle’ is underwritten by the theory**
- **A puzzle is characterized by the theory (including the norms of its possible successes of a solution)**
- **Puzzles, conversely do not undermine theories.**

*~Normal Science is the ‘norm’~*

On the other hand, the ‘testing’ processes Karl Popper is fond to cite as being emblematic of the advancement of science, are rare and describe **revolutionary** or **extraordinary science**.

“[T]he tests which Sir Karl emphasizes are those which were performed to explore the limitations of accepted or to subject a current theory to maximum strain...in using them to characterize scientific activity Sir Karl misses something terribly important about them. **Episodes like these are very rare in the development of science.** When they occur, they are generally called forth either by a prior crises in the relevant field...or by the existence of a theory which competes with the existing canons of research...’**[E]xtraordinary research’ [is] an enterprise in which scientists do display very many of the characteristics**

---

<sup>2</sup> This distinction is one of Kuhn’s most essential notions, as we’ll see when we look at selections from his classic: *Structure of Scientific Revolutions* (1962), for instance.

<sup>3</sup> I worked on this problem when employed as a Research Assistant at GTRI (Georgia Tech Research Institute) in the Acoustics and Radar Division (1991-1992).

**Sir Karl emphasizes, but one which...has arisen only intermittently and under quite special circumstances...”**

(-ibid., CC 1998, p. 13)

*Examples:*

- Gravity lens effect** (Eddington 1919) (Newtonian mechanics vs. General Relativity)
- Calcination** (Lavoisier, ca. 1776) (Phlogiston vs. oxygen theory)
- Parity conservation violation** (Lee & Yang 1959) (QCD vs. ???)

*~ ‘Revolutionary’ Science is the ‘exception’~*

**Furthermore:**

“[T]hough testing of basic commitments occurs only in extraordinary science, **it is normal science that discloses both the points to test and the manner of testing.**”

(-ibid., CC 1998, p. 14)

“[I]t is for the **normal**, not the extraordinary practice of science that professionals are trained.”

(-ibid., CC 1998, p. 14)

“If a demarcation criterion exists (we must not, I think, seek a sharp or decisive one), it may lie just in that part of science which Sir Karl ignores...In a sense [however] severity of test-criteria is simply one side of the coin whose other face is a puzzle-solving tradition. That is why Sir Karl’s line of demarcation and my own so frequently coincide. That coincidence is, however, only in their *outcome*; the *process* of applying them is very different, and it isolates distinct aspects of the activity about which the decision—science or non-science—is to be made. ”

(-ibid., CC 1998, p. 14-15)

### *Biological Analogy*

- ✦ For Popper, theories are like individual ‘animals/ organisms’ ...constantly subjected to the harsh environment of falsifiability.



- ✦ Their ‘fitness’ is determined by how they’re able to meet specific tests (akin to life/death competitions).
- ✦ Conversely, for Popper, those ‘animals’ sitting idly by, unable to, by their very own make-up, compete in such ultimate tests for survival are automatically ruled out from the game of science.



- For Kuhn, on the other hand, theories & theoretical frameworks (‘paradigms’) function more like an animal *species*.
- Their “fitness” is ultimately determined by their long-term adaptability in the following way:
  - During “normal periods” such a species is in (relative) homeostatic equilibrium in its environment...adaptability challenges present themselves as individual ‘puzzles’ for the ‘organisms’ (specialized communities practicing the theory)
  - However, as time goes on, ‘hard problems’ (anomalies) accrue...which can
  - ...Result in either a change in constitution analogous to “mutations”

OR...

#### 4. Extinction/bifurcation/ radical species-change (analogous to ‘extraordinary’ science produced in ‘crisis’)

- Case study: Astrology

(contra Popper):

- a) Astrology isn’t a pseudo-science because of the form of its predictions (many of which were falsified by practicing astrologers).
- b) “Nor can it be barred because of the way its practitioners explained failure...[o]nly after astrology itself became implausible did the[ir] arguments appear as questions-begging.” (CC1998, p. 16)
- c) **But this seems to be a contingent question of historical hind-sight!** “Similar arguments are regularly used today when explaining...failures in medicine or meteorology. In times of trouble they are also deployed in the exact sciences, fields like physics, chemistry and astronomy.” (ibid.)

...So what does distinguish the mere craft or formerly known practical art of astrology (similar to early medicine, etc.) from a science like astronomy (whether ancient, modern, or contemporary)?

- Answer: “If an astronomer’s prediction failed and his calculations checked, [s/]he could hope to set the situation right. Perhaps the data were at fault...[o]r perhaps theory needed adjustment...**The astrologer, by contrast, had no such puzzles...**without puzzles, able first to challenge and then to attest the ingenuity of the individual practitioner, astrology could not have been a science even if the stars had, in fact, controlled human destiny.” (CC1998, pp. 16-17)

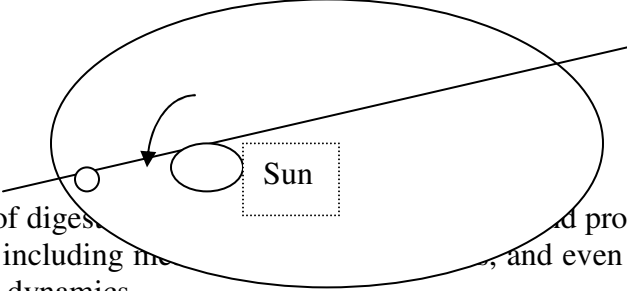
### *Imre Lakatos*

“We have to define experimental reasoning...**how exactly can facts support theory?**”

“Science and Pseudoscience”  
CC1998 (p. 21)

- **Contra Popper:** Falsificationism “ignores the remarkable tenacity of scientific theories. Scientists have thick skins. They do not abandon a theory merely because facts contradict it.” ( ibid., CC1998, p.23) “[T]rivial trial and error does not rank as science...the ‘hard core’ [i.e., a theory’s fundamentally constituent laws] is tenaciously protected from refutation by a vast ‘protective belt’ of auxiliary hypotheses...[e]ven more importantly the research programme has... a powerful problem-solving machinery, which, with the help of sophisticated mathematical techniques, digests anomalies and even turns them into positive evidence.” (ibid., CC1998, pp.23 - 24)

**Example:** In Newtonian celestial mechanics, the perihelion shift of Mercury is anomalous (in the sense that its measured value deviates from what the theory predicts).

- 

The arsenal of digests... and protective belts of auxiliary assumptions including me..., and even ‘explanations’ resorting to non-linear dynamics

- **Contra Kuhn:** Is a ‘paradigm shift’/ scientific revolution no more (or less) rational than a “religious conversion?...[I]f Kuhn is right, then there is no explicit

demarcation between science and pseudoscience...no objective standard of honesty.” (ibid., CC1998, p.23)

“I claim that the typical descriptive unit of great scientific achievements is not an **isolated hypothesis** but rather a **research programme.**” (RP)

An RP should be viewed as a (relatively autonomous) coherent unit of scientific specialties and subspecialties whose communities consist not just of the particular advancement of a theoretical position (or cluster thereof) but also of a coordination of experimental practices and problem-solving/anomaly-digesting machinery under the rubric of such theories and theoretical positions.<sup>4</sup>

- Active or robust RPs “predict novel facts...which have either been undreamt of, or have indeed been contradicted by previous or rival programmes.” (CC 1998 p. 24)
- “[I]n a **progressive RP, theory leads to the discovery of hitherto unknown novel facts.** In degenerating programmes, however, theories are fabricated only in order to accommodate known facts.”

a) Hence (contra Popper) “so-called ‘refutations’ are not the hallmark of empirical failure...all programmes grow in a permanent ocean of anomalies. **What really count are dramatic, unexpected, and stunning predictions.**” (p. 25) “**Important criticism is always constructive: there is no refutation without a better theory.**” (26)

b) **Kuhn’s ‘revolutions’** are descriptions of what occurs when there are “two [or more] rival RPs, and one is progressing while the other[s] is/[are] degenerating, scientists tend to join the progressive programme.” (25)

**In other words, revolutions are rational process, not bare ‘conversions’!** (Consider, e.g., L. Smolin’s (2006) *The Trouble With Physics*, in which he argues that String Theory is an example of a degenerating RP.)

---

### *Paul Thagard*

“I shall propose a complex criterion for distinguishing disciplines as pseudoscientific... [which] introduces **social** and **historical** features as well as **logical** ones.”

---

<sup>4</sup> Recall August 30<sup>th</sup> lecture...the ‘Contemporary’ philosopher of science’s object of study being not just some textbook-ready theory/’product,’ rather the *processes* undergirding theory-generation vis-à-vis experimental testing and design.

“Why Astrology is a Pseudoscience” CC1998, p. 27

- *Case study: Astrology revisited*

“Ptolemy took astrology as seriously as he took his famous work in geography and astronomy... The European Renaissance is heralded for the rise of modern science, but occult arts such as astrology and alchemy flourished as well.” (28)

Revived interest, Bok & Jerome’s (1975) criticisms:

- **Based on “magical principle of correspondence” (no well-defined causal or physical mechanisms to underwrite statistical correlations.<sup>5</sup>)**

**Objection 1:**

“[T]he lack of a physical foundation hardly makes a theory...unscientific” (continental drift/ smoking & lung cancer proposals) (p. 28)

- **Origins in a ‘magical world view’**

**Objection 2:**

“[O]rigins are irrelevant to scientific status. The alchemical origins of chemistry and the occult beginnings of medicine are as magical as those in astrology, and historians have detected mystical influences in the work of many great scientists, including Newton and Einstein.” (ibid., p. 28)

- **Based on ‘wishful thinking’ (“desperation in seeking solutions to...serious personal problems.”)**

**Objection 3:**

“[T]he psychology of popular belief is...in itself irrelevant...people often believe even good theories for illegitimate reasons, and even if most people believe astrology for personal, irrational reasons, good reasons may be available.” (ibid., p. 28)

**Sufficiency condition for a verifiable theory?**

If it’s possible to deduce observation-statements from a theory  $T$ , then  $T$  is verifiable.

**BIG Objection 4:**

---

<sup>5</sup> As Thagard further reviews, such correlations themselves are controversial, different studies refute each other’s conclusions here (pp. 30-31)

As we'll see later in the course, this is highly problematic, if not intractable notion! "Attempts [for example] by A. J. Ayer to articulate the principle failed wither by ruling out most of science as unscientific, or by ruling out nothing. Moreover, the theory/observation distinction has increasingly come into question. All that remains is a vague sense that testability somehow is a mark of scientific theories. Well, astrology *is* vaguely testable." (p. 30)

**Inherent vagueness (rendering astrology unfalsifiable, in Popper's scheme?)**

**Objection 5:**

"[T]he doctrine of falsifiability faces serious problems...Popper himself noticed early that no observation ever guarantees falsification: a theory can always be retained by introducing or modifying auxiliary hypotheses, and even observation statements are not incorrigible." (p. 30) (Recall Lakatos, falsifiability alone is insufficient, as it "only occurs when a better theory comes along...only a matter of replaceability by another theory...since astrology is in principle replaceable by another theory, falsifiability provides no criterion for rejecting astrology as pseudoscientific." (p. 31)

- A socio-historical/logical account (p. 31):

Demarcation requires:

-**Theoretical context** (the *logical* component)

(traditional issues of falsification/ observation/ prediction/ explanation...fit here. "[W]e have seen that this approach is not sufficient in characterizing astrology as a pseudoscience." (31))

- **Communal context** (the *sociological* component)

*Agreement* among practitioners on principles/ problem-solving methods? Are the practitioners *concerned* about explaining anomalies? *Active involvement* in attempts to [dis/]confirm?

-**historical context** (the historical component)

Kuhn showed that there must be a *prolonged* and *sustained* barrage of anomalies *and* there must be another challenger.

**Revised Demarcation Principle (RDP) (Note the logical equivalence!) (p. 32)**

***T* is pseudoscientific ↔ a) Faces many **unsolved problems**, and has **been less progressive in the long run compared to alternatives.** & b) Community "runs out of steam;" i.e. **exhibits less energy and drive toward solving *T*'s problems & anomalies, exhibits diminishing incentive to evaluate theory in the face of other****

**alternative(s)  $T^*$ , including, for that matter  $T$ 's  
[dis/]confirmations in relation to alternatives.**

Example: The 'caloric fluid' theory of heat (18<sup>th</sup> cent) prior to the kinetic theory

...So, astrology *is* pseudoscientific because (32):

- a) “[D]ramatically unprogressive...has changed little and has added nothing to its explanatory power since the time of Ptolemy.” (**Historical/logical**)
- b) Problems (like precession of the equinoxes) remain. (**Historical/logical**)
- c) Alternative theories of personality/behavior abound. (**Logical**)
- d) Community of astrologers appear unmotivated to advance field insofar as overcoming its outstanding problems/anomalies. (**Sociological**) “What makes astrology pseudoscientific is not that it lacks periods of Kuhnian normal science, but that its proponents adopt uncritical attitudes of ‘normal’ scientists despite the existence of more progressive alternative theories.” (p 33)

- According to **RDP**, science/pseudoscience is a boundary that can shift over time “a theory can be scientific at one time and pseudoscientific at another.” (p. 33)
- Does the **RDP** entail cultural relativism? “[A] communication network to which a community has, or should have, access...(perhaps against Kuhn)...is a general feature of rationality...at least sufficient to preclude **ostrichism** [i.e. a deliberate attempt to avoid reality] as a defense against being judged pseudoscientific.” (34)

“My concern is social: society faces the twin problems of lack of concern with the advancement of science, and lack of public concern with the important ethical issues now arising in science and technology.” (p.34)