I. The Unobservable-Observable Distinction (UOD)

A. UOD’s Importance to the Realism Debate

1. Constructive Empiricism: science aims to have empirically adequate theories.
2. A theory is empirically adequate if and only if what it says about observable entities is true.
3. ∴ If constructive empiricism is true, then science aims for theories that say only true things about observable entities. (From 1, 2)

B. Issues with UOD

UO1. Any distinction between unobservable and observable entities is arbitrary.
UO2. If UOD is arbitrary, then what is unobservable is as knowable as what is observable.
UO3. If what is unobservable is as knowable as what is observable, then science should aim for theories that say true things about both observable and unobservable entities, i.e. realism is true.
UO4. So, realism is true.

C. Maxwell’s Arguments (Summarized) for UO1

1. Mediation Objection: “there is, in principle, a continuous series beginning with a looking through a vacuum and containing these as members: looking through a windowpane, looking through glasses, looking through binoculars, looking through a low-power microscope, looking through a high-power microscope, etc.”
2. Mutation Objection: “Suppose that… a new drug is discovered which vastly alters the human perceptual apparatus…[and] that in our altered state we are able to perceive … in a manner roughly analogous to that by which we now see by means of photons.”

D. Van Fraassen on the UOD:

1. In his own words: “The human organism is, from the point of view of physics, a certain kind of measuring apparatus. As such it has certain limitations—which will be described in detail in the final physics and biology. It is these limitations which the ‘able’ in ‘observable’ refers—our limitations, qua human beings.” (1980: 17)
2. Hacking’s Gloss on BF: Something is observable “by the use of an optical instrument only if human beings with fairly normal vision could have seen that very thing with the naked eye.” (135)
   • Addresses both of Maxwell’s Objections

II. Hacking on the Unobservable- Observable Distinction

A. Main Thesis: Van Fraassen’s account of observability does not accord with scientific practice.

B. The Microscope Argument

M1. According to scientific practice, an entity is observable if there is an accurate model of the interactions between the specimen and the detector’s imaging radiation.
M2. According to scientific practice, a model of these interactions is accurate if:
   a. Its results are robust, i.e. two or more modes of detection yield the same result, and
   b. We can use the detector’s results to manipulate the specimens represented by that model.
M3. It is possible for a model of the interactions between a specimen and a detector’s imaging radiation to be robust and manipulable, yet human beings with normal vision could not have seen the specimen with the naked eye.
M4. ∴ Van Fraassen’s account of observability does not accord with scientific practice. (From M1-M3)
C. **Examples of Robustness (M2)**
1. **Dense bodies:** An electron microscope shows red spots or “dense bodies” on red blood cells. A fluorescent microscope shows these same red spots.
2. **Grids:** Grids on a microscope slide are made at the macroscopic level and then reduced photographically. The macroscopic image of the grid is then reproduced through many different kinds of microscope.

III. **Objections to Hacking**

A. **Is This Really Observability?**
1. Hacking describes how scientists currently use the word ‘observe’ and ‘see,’ etc. but van Fraassen’s account of observability—which appeals to the “final physics and biology”—is also scientifically respectable.
2. Hacking’s mixed verdict: “This is doubtless a liberal extension of the notion of seeing,” but “I know of no confusion that will result from talk of seeing with a microscope.” (151)

B. **Is Robustness Just the No Miracles Argument Warmed Over?**
Hacking anticipates this, and offers four replies.
1. There is no distinction between observational and theoretical vocabulary. (145), as “dense body” is simply something that appears under the electron microscope without staining.
   a. Reply: But not all IBE’s trade in unobservables.
2. “We are not concerned with explanation. We see the same constellations of dots whether we use an electron microscope or fluorescent staining, and it is no ‘explanation’ of this to say that some definite kind of thing (whose nature is as yet unknown) is responsible for the persistent arrangement of dots.” 146
   a. Reply: This is a straw man. IBE can be glossed without invoking unknown natures:
      i. Both electron and fluorescent microscopes indicate that red blood cells have dense bodies.
      ii. The best explanation of this is that red blood cells have dense bodies
      iii. So red blood cells have dense bodies.
3. We have no theory that predicts some wide range of phenomena.
   a. Reply: Neither “theory” nor “range of phenomena” need be very precise terms for IBE to get off the ground: in this case, we simply need an explanation (that red blood cells have dense bodies) and the fact that two independent sources indicate as much is a way of ruling out a competing explanation (that the red spots are artifacts of the electron microscope) which would explain/predict a narrower range.
4. Microscopists’ concern is between distinguishing a real phenomenon from a mere artifact; realists’ concerns are between distinguishing a real though unobservable entity from a mere tool of thought.
   a. Reply: unclear that realists are committed to this contrast or simply between a real observable entity and an unreal one.

C. **Is This Relevant to the Realism Debate?**
Even Hacking isn’t so confident!
1. For all that Hacking has said, objects detected by a microscope are observable, but they may not even be real.
2. Furthermore, as long as some entities are unobservable, some (revised) version of constructive empiricism can survive.