UNCERTAINTY, DETERMINISM, SCIENTIFIC METHOD, AND THE WISDOM OF FRANZ BOAS

(AND A MESSAGE FOR THEOLOGY)

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Saturday, July 30, 2011

#### WHAT THIS TALK IS ABOUT

The effect of the human desire for rational certainty on science, and on how it is perceived by the public

The appearance of uncertainty in physics: causal explanations supplemented by probabilistic ones

Scientific theories are not "THE Laws of Nature"

### WHAT THIS TALK IS ABOUT

Why it is misleading to

Use the methods of physics as a template for "THE" Scientific Method

Second Second

Take theological conclusions from science too seriously

### **TERMS OF CONTRAST**

Ontology vs. Epistemology

Deterministic or causal vs. chance, random, probabilistic or uncertain

Simplicity vs. complexity, repeatability vs. uniqueness

 Cataphatic vs. apophatic approach to theology
Analytic vs. holistic, reason vs. experience, conscious vs. unconscious

### **TERMS OF CONTRAST**

Synchronic vs. Diachronic empirical methods

Terms originated in Linguistics -- Frederick Saussure (1916), first used more broadly by Claude Levi-Strauss.

Structural linguistics is synchronic. No problem recognizing it as "science."

Sethnography is diachronic: descriptive field notes, etc. subtleties of linguistic usage, influence of language on thought and understanding

#### **DIACHRONIC EVIDENCE**

Field or clinical notes, recordings, videos

Records of oral tradition, personal histories, psychotherapy records, other narratives

Accounts of observant participation in ceremony, literature, art, poetry, prayer

# Historical records, historical studies

Other types of case studies

#### Dialogues

# FRANZ BOAS





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### THE WISDOM OF FRANZ BOAS

- # Human science must emphasize "diachronic" observation
- # All individuals, cultures and social groups are unique
- \* Measurement and classification, which are essential in natural science, are of less value in the human sciences of linguistics, ethnology, sociology, psychology
  - Statistical methods use "synchronic" data which can only play a secondary role in human science

### SYNCHRONIC AND DIACHRONIC DATA: SOME EXAMPLES

- Synchronic: Boas' study of New York City immigrants' cranial plasticity (physical anthropology)
- Diachronic: Freud's Interpretation of Dreams
- Laboratory Life by Bruno Latour and Steve Woolgar
- Both: Benjamin Whorf's study of the Hopi language: structural linguistics plus observant participation
- Diachronic: Numerous studies of Christian contemplative prayer
- Utterly synchronic: The "dismal science"

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### DETERMINISM AND MODERNISM

\*\* Ontological determinism, suggested by Newton's mechanics, prevailed increasingly in science from the mid-eighteenth century into the twentieth.

Darwin's natural selection was widely interpreted in this context

# "All the laws of nature have been discovered."

Beyond science, "Modernism" and sciencebased technology captured the public imagination. "...in a few years, all the great physical constants will have been approximately estimated, and ... the only occupation which will then be left to the men of science will be to carry these measurements to another place of decimals." (James Clerk Maxwell, 1871)

"The more important fundamental laws and facts of physical science have all been discovered, and these are now so firmly established that the possibility of their ever being supplanted in consequence of new discoveries is exceedingly remote. Our future discoveries must all be looked for in the sixth place of decimals." (A. A. Michelson, 1894)

### THE DEMISE OF ONTOLOGICAL DETERMINISM

Uncertainty first entered science in statistical physics

It challenged the ontological determinism of many scientists

Boltzmann committed suicide

Special and general relativity refuted the notions of absolute space and time. Newton's Laws were no longer "THE Laws of Nature"

Quantum physics and nonlinear dynamics pose an even greater challenge

### QUANTUM PHYSICS AND NONLINEAR DYNAMICS

- Quantum theory appears to place probability, and thus, apparently, "randomness," in the very heart of natural science.
  - # However, quantum theory is deterministic in the unobservable, infinite-dimensional space of "quantum states" or systems
  - Severy quantum system is coupled nonlinearly and non-locally to all others, in particular to its environment and any measurement apparatus
  - Information is transferred between systems, and is lost when measurements are made. The observed measurements must sometimes be described probabilistically.

If the coupling with the environment is <u>chaotic</u> there is an additional source of uncertainty.

### DECOHERENCE AND "QUANTUM JUMPS"

Quantum "jumps" occur between allowed states of a system. In decoherence theory they are very rapid but continuous transitions.

The allowed states are determined by the environment due to strong, non-local coupling.

The dynamics of the coupling are governed by generalized Schrödinger equations.

Some transitions are just slow enough to be measured, and results are in agreement with decoherence theory predictions.

### THE MISPERCEPTION OF QUANTUM PHYSICS

The apparently fundamental nature of randomness in quantum theory has

Led most physicists to avoid investigations of its foundations

"Shut up and calculate" in particle physics

Led some philosophers and non-physicist scientists to assume that chance is ontological

Left the public totally confused and mystified.

"The eyes of the scientist are directed upon those phenomena which are accessible to observation... In the attempt to achieve a conceptual formulation of the confusingly immense body of observational data, the scientist makes use of a whole arsenal of concepts which he imbibed practically with his mother's milk; and seldom if ever is he aware of the eternally problematic character of his concepts. He uses... these conceptual tools of thought as something obviously, immutably given; something having an objective value of truth which is hardly ever...to be doubted. How could he do otherwise?....And yet in the interests of science it is necessary ... to engage in the critique of these fundamental concepts, in order that we may not be ruled by them. [italics mine.] This becomes evident...[when]...the consistent use of the traditional fundamental concepts leads us to paradoxes difficult to resolve."

Albert Einstein, quoted as an introduction
to *Concepts of Space* by Max Jammer (2nd Edition)

### UNCERTAINTY IN EMPIRICAL SCIENCE

\* Measurement and classification are the essence of empirical natural science, and statistical analysis of data is essential.

Statistical inference allows scientists to draw probabilistic conclusions about a *population* of individuals from a finite *sample*.

# However, conclusions about *populations* have limited applicability to *individuals*.

Generalizability decreases as individual complexity increases. In human science, individuals matter

### UNCERTAINTY IN EMPIRICAL SCIENCE

The myth of "objectivity" -- examples:

- W. H. Youden's "Enduring Values" (*Technometrics* vol. 14, pp. 1-11, 1972)
  - Measurements by different observers and in different laboratories show systematic variations
- Classification can be fraught with ambiguity, and lead different observers to different conclusions

Linnaean approach vs. "cladistics"

### UNCERTAINTY IN EMPIRICAL SCIENCE

Reproducibility of results is the hallmark of empirical natural science; complexity limits reproducibility

Particles, atoms and molecules of the same species are pretty much the same -- until the molecules get large, like many proteins

Individual members of a biological species exhibit substantial variation

Individual humans, their social groups, and their languages and cultures, exhibit enormous variability

### THE MESSAGE FOR THEOLOGY -- AND SCIENCE

\*\* All human knowledge is uncertain, not only quantitatively but conceptually

Reason must always yield to the data of experience

- In the human sciences statistical methods can only supplement diachronic approaches.
- Interfaith and cross-cultural studies of human spirituality are essential to sound theology, but also for global mutual understanding.

## THE MESSAGE FOR THEOLOGY -- AND SCIENCE

- \* Accept the limitations of human knowing and the reality of mystery.
- Ontological claims should be banned from science and rational philosophy
- \* Apophatic theology is undervalued, cataphatic theology is overvalued.