Insight & Beyond: Lecture 9, Part I: *Insight*, Chapter 5, Explanatory Space & Time: Special Reference Frames

[0:00]
• Discussion of students' papers on an insight they had.
• Wide range of situations. How pervasive insights are.
• Comments about how the assignment – "Describe *an* insight you have had." – opens onto even more activities for self-appropriation – especially, learning to differentiate insight and inquiry.
• Taking the time to describe one insight inevitably reveals oneself as having many insights in a self-correcting process.
• The distinctive feature of being human is being an inquirer – inquiry as the fundamental movement of self-transcendence.

[8:33]
• Shift from personal and public reference frames of the commonsense mode of understanding, to 'special' reference frames.
• Scientific/explanatory understanding's concern to relate everything to everything else – relate every extension and duration to every other, none privileged.
• Science does not privilege any reference frame.

[11:50]
• Special reference frame begins by with stipulating a particular standpoint, instant, and orientation, (as do personal reference frames).
• Using insights, order other extensions and durations in relation to the selected origin and orientation.
• Recognition of indefinite multiplicity of special reference frames raises a problem for classical scientific statements of how things relate to one another.
• Transposing from one reference frame to another is not unique to scientific/explanatory reference frames; it is also an achievement of commonsense in transposing personal reference frames.
• Piaget (and Lawrence Kohlberg) studied stages at which children were to be able to master the transposition to another point of view (spatially) as a prelude to having ethical empathy for another's concerns.
• What makes it possible for human beings to know how things will look from a location which they do not actually occupy? Insight, imagination, and inquiry. Inquiry draws us out of the limits of our own experiences. Inquiry and insight makes possible self-transcendence from one reference frame and one culture to another.

[19:08]
• Student questions about terminology: transformation versus transposition; transformation and conversion.
• Discussion of intellectual versus existential transformations. Insights that take one beyond the limits of one's intellectual organization of a spatio-temporal reference frame (second level of consciousness) vs. deliberating and choosing to live according to a different scale of values (fourth level of consciousness).

[22:00]
• Since classical laws and principles are abstract, they are invariant over differences of particular places and times.
• What does "invariance of formulation/expression" mean?
• Yet some terms ('left') vary with orientation. This poses a problem for physics.
• Hence, Invariance is a test for whether a classical correlation is truly explanatory.

• Laws of motion should be free of local variance and particularities. Example of Galileo's law.
• Yet can't do physics without some particularity; some particularity is required for physics because its measurements always originate from instruments at a particular place (earth), although laws have to be general.
• Scientists make observations and gather numbers for the sake of arriving at something beyond numbers.
• It isn't scientific just because it has numbers associated with it. Numbers are on the way to something more important – namely, covariant correlations.
• Clarification of technical meaning of *co-variant correlation* (e.g., equation) versus *invariant numbers*. *Numbers* gathered at different times and at different location can differ, although their variations compensate for one another to leave correlations invariant.

[31:37]
• Special reference frames and transformations.
• Changing the origin points of the Cartesian coordinate system is one kind of transformation.
• Expressing this change in origin points by a transformation equation that shows how general reference frames relate to one another.
• Transformation equation starts by relating one origin point to another, but then also makes it possible to transform the relation of any point to one origin into the relation to another origin.

[35:33]
• From geometrical considerations, can work out transformations?
• From transformations, can work out the geometry (i.e., the geometrical considerations).
• What do we need to know, in order to construct the ordering of Cartesian reference frame?
• Among other things, need to be able to draw parallel lines and to understand how they differently relate to one another in the different geometries – especially in Euclidean (Cartesian) geometry.
• The ordering of extensions to one another in Euclidean geometry is mediated by their relations to parallel lines.

[44:00]
• How do you know all points are covered? Because in a merely mathematical reference frame, you get to intelligently and creatively select the rules (intelligible relations) of the kind of geometry.
• Example of Euclidean geometry and Euclidian space.
• Key to intelligibility of Euclid's world is parallel lines. Covariant expression.
• Oversight of insight: forgetting that the initial premises implicit in the mathematical geometry were the introduced by the intelligent construction of the mathematician.

[46:47]
• But what if we turn from mathematical to a empirical, physical, special reference frames. Then the intelligibilities (the "geometrical considerations") are not simply up to the intelligent selectivity and creativity of the empirical scientist.
• What happens if the physicist has to actually construct a reference frame under the conditions imposes by the physical universe? What problems would a physicist encounter in attempting to construct a physical reference frame? Would he or she actually be able to make it turn out Euclidean/Cartesian?
• How do we know how parallel lines truly behave in real, physical space?
• How to determine if lines are parallel in physical space? Use a light ray, like a laser pointer.
• But what if light curves? What other standard of straightness could one use besides a light ray?
• What if Euclidean and Galilean "geometrical considerations" are not true of the physical world?

• This was the gist of Einstein's critique of Euclidean/Galilean assumptions about physical Space and Time.

[51:43]
• More illustrations of transformations.
• An example of an equation that is *not* covariant with respect to a transformation. So it could not be an example of a truly explanatory, classical correlation.

[55:12]
• Further example of a dynamic transformation from one reference frame to another moving inertially with respect to the first.
• Where things are relative to the second reference frame constantly change.
• This is called a Galilean transformation.
• The Galilean transformation gets a sophisticated, metaphysical formulation in Newton's presuppositions about absolute space, time, and motion.
• Especially, the assumption that time is the same for all moving reference frames.
• Absoluteness presupposed so we can have an absolute science of motion and invariant classical correlations (laws).
• Einstein (preceded by Berkeley) said Newton privileged one particular was absolute.

[1:02:18]
• If do not presuppose an absolute Space and Time, how is it possible to have invariant, classical correlations?
• Einstein's intellectual career began with intellectual dissatisfaction, in wonder and inquiry as to why the laws of electromagnetism were not covariant under inertial transformations.
• Why two different expressions to express one relationship?
• What the principle of relativity really means: not privileging any particular reference frame.
• Principle of relativity tells how to transform one reference frame into another.
• Einstein was convinced that there was an invariant (co-variant) intelligible relatedness to all of electromagnetic phenomena, and this led him to assert the law of the constancy of the velocity of light.

[1:08:09]
Relativity of the Simultaneity of Time.
Famous train and lightning example as given by Einstein in his *Relativity: The Special and General Theory.*
• Neither person has a privileged reference frame?
• But each person has as different perception of the timing of the events (simultaneous or sequential).
• Measurements of times of occurrence are different, but can be calculated for (transformed into) the other.
• Therefore, simultaneity of events not absolute.

[1:12:49]
Student questions:
- Isn't the true reference frame where the lightning actually strikes the tracks? Put sensors on the track to get the true timing.
- This would lead to the same conclusion.
- Not a question of where the lightnings strike, but when.

• The strangeness of the non-simultaneity of time.

  - Is the relativity due to our definition of our perception? Because observers *see* bolts at the same or at different times?

• Einstein called this a *Gedankenexperiment* – This is a thought experiment. One can imagine away complications to get to the essential point.
• Not just perception of the events, but the perceptions as interpreted and adjusted by insights and
  - What if measure the tracks, where the bolts strike.

• Concretely, if actually try to measure these distances, need to invoke simultaneity of time measurements as well.
• Einstein realized that cannot assume that time does not enter into spatial measurements, and that space does not enter into temporal measurements.
• He realized that Space and Time are not structured the way that Galileo and Newton assumed.
• In a parallel way, in Kevin Lynch's book, *What Time is this Place?* reveals the historicity of human spatial meanings.

[1:25:37]
• Why is this experience of Space and Time so strange?
• Inverse insight that uniform motion has no intelligibility of its own and thus makes no contribution to classical correlations.
• No privileged frame of reference, no particular space and time. Runs counter to our existential rootedness in our public reference frames.
• Lonergan critiques Galileo, Newton, Kant for thinking that science must be about the necessary: They were looking for the absolute, but they were looking for it in the wrong place.
• Really just privileging themselves.

[1:30:20]
• Curved and hyperbolic geometries. Angles add up to more than 180 and parallel lines are different.
• Outside of Euclidean space, odd things happen. Things relate differently, and these different relations can be verified empirically.
• These are completely plausible versions of the real, physical explanatory space.

End of Part I.