Generalization of Principle of Equivalence

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This lecture discussed the mathematics, the physics and the philosophy of principle of equivalence to understand its nature and scope itself as a fundamental principle. The weak version states that it is possible to choose *a locally inertial coördinate system*, at every spacetime point in an arbitrary gravitational field, such that, within a sufficiently small region of the point in question, "the laws of motion of freely-falling bodies" take the same form as in unaccelerated-cartesian-coördinate systems in the absence of gravitation. In the strong version "the laws of motion of freely-falling bodies" are replaced by "the laws of nature". The medium-strong principle applies to all phenomena except gravitation itself, whereas very-strong principle applies to all phenomena. Einstein's general theory of relativity is based on the strong version. The equivalence principle appears to hold only locally, but not globally. The speaker introduced possible approaches to generalization of principle of equivalence to inhomogeneous, anisotropic and time-varying gravitational fields and, hence, write a generalized-Robertson-Walker line-element, using local-perturbation formulation. It was assumed that the gravitational field was homogeneous and stationary in an infinitesimal volume during a short span of time. Connection coefficients might, then, be used to write appropriate expressions of the generalized principle of equivalence. This lecture was dedicated to the memory of our beloved colleague, Prof. Dr. Q. K. Ghori (1932-2009), who passed away last year on May 17. Prof. Ghori got his MSc from University of Karachi in 1952 and PhD from University of British Columbia, Vancouver, Canada in 1961. During 1952-55, he taught at DJ Government Science, College, Karachi, affiliated with his alma mater (University of Karachi), where he had the honor to teach Dr. Abdul Qadeer Khan, NI (Bar), the renowned nuclear scientist of Pakistan. In 1955, he joined University of Sindh, Jamshoro. Upon his return from Canada (1961), he joined the Quaid-é-Azam University, Islamabad, as Associate Professor, becoming Full Professor in 1966 and held the posts of Acting Director of National Institute of Modern languages (1970-72), Professor-in-Charge of Computer Center (1968-73) and Dean, Faculty of Natural Sciences (1973-75). Other universities, which benefited from his vast experience and scholarship, are Garyounis University, Libya (1979-82, 1983-84), the King Fahad University of Petroleum and Minerals (FUFPM), Dhahran, Saudi Arabia (1988-94) and the Ghulam Ishaq Khan (GIK) Institute of Engineering Sciences and Technologies, Topi, KP (1994-2000). At GIK he served as Dean, Faculty of Engineering Sciences (1996-98) and Pro-Rector (1999-2000). At the time of his sad demise, he was serving as Advisor, the COMSATS Institute of Information Technology, concurrently serving as Treasurer, the Pakistan Academy of Sciences, the institution, which elected him Fellow in 1974. In 1975, he was awarded the Sir Shah Suleiman Memorial Prize. His professional memberships included the All Pakistan Mathematical Association (Past President), the Karachi Mathematical Association, the Pakistan Association for Advancement of Science, the Pakistan Association for History and Philosophy of Science, the Pakistan Scientific Society and the Punjab Mathematical Association. He supervised MPhil thesis of Mrs. Rashida Fahim, who taught at my university for more than two decades. Almost, every student of mathematics in the entire country has benefited from his classic book on mechanics (taught in BSc). Prof. Ghori has left behind 2 sons and 3 daughters. Mathematics community cannot recover back from this great loss. Some of the very last pictures of Prof. Ghori (taken on May 12, 2009) were shown during the lecture.

Fig. 1. Prof. Dr. Q. K. Ghori (center) with speaker (wearing ID card) during 4th CCIS (May 12, 2009)

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