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Hamilton-Jacobi equation based on exterior derivative

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Analytical Mechanics of fields usually singles out the temporal coordinate as an independent parameter and calculates the time evolution regarding fields as dynamical parameters with infinite degree of freedom. Spatial coordinates are treated as infinit number of indexes of dynamical parameters. This approach has a disadvantage when applied to electromagnetism: the resulting equations are not manifestly covariant. Moreover, when applied to gauge fields, the canonical theory with this approach has extra degree of freedom, which need to be eliminated with some constraints. One must fix the gauge at the price of loosing manifest covariance, or introduce some
complicated technique such as Dirac brackets.

The author reported the way to treat four (time 1 + space 3) parameters equally to construct analytical mechanics at the fall SGEPPS meeting. The expression obtained is manifestly covariant, and there is no need for gauge fixing when applied to gauge fields. The present study is to extend it to Hamilton-Jacobi theory. Also, possible application to the fluid dynamics will be discussed at the presentation.

The name of Hamilton-Jacobi equation is well known by name, however, not many researchers try to understand its detail because it is not quite useful to solve actual problems. However, it is conceptually important for the deep understanding of analytical mechanics. Also, it is essential to introduce quantum mechanics based on the knowledge of classical mechanics.

Several attempts have been made to establish classical mechanics of relativistic fluid dynamics, but fully covariant expressions are yet to come. Kambe (2010) has reported the Euler equation can be cast into the form of Maxwell equation with appropriate definitions of variables. The present study has been successfully applied to the analytical mechanics of electromagnetism, therefore, it may be applicable to fluid dynamics based on Hasimoto's representation.

References:
T.K. Nakamura 2003 (http://hdl.handle.net/2433/97295)[In Japanese]
T. Kambe 2010, Fluid Dyn. Res.
Y. Kaminaga, Electronic Journal of Theoretical Physics, 2012 (http://www.ejtp.com/ejtpv9i26)

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