Moment models for magnetized Vlasov equations *

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Moment models are an important avenue for the numerical modeling of transport equations. In the recent literature, we refer to [1] for transport equations with linear relaxation and to [2] for the construction of moment models for Vlasov-Maxwell equations. In fusion plasma community, the classical approach for Hermite-Laguerre moment models to gyro-kinetic equations is described in [3] and references therein.

The MUFFIN ANR project aims at developing moment models for magnetized Vlasov equations: `https://www.ljll.math.upmc.fr/~despres/MUFFIN/muffin.html`. A starting point for the presentation will be a Hermite based moment model for the simplified equation with strong variable magnetic field

$$\partial_t f + \mathbf{v} \cdot \nabla_x f + \mathbf{v} \times \mathbf{B}_0(\mathbf{x}) \cdot \nabla_v f = 0. \tag{1}$$

Three features will be discussed: a) the full Hermite model recovers a Hermite-Laguerre gyro-kinetic moment model in the limit $|\mathbf{B}_0(\mathbf{x})| \to \infty$; b) a "seemingly novel" generating formula for Laguerre polynomials; c) the possibility of hierarchies of models approaching the gyro-kinetic limit.

References

[1] C. Buet, B. Despres and G. Morel, Trefftz discontinuous Galerkin basis functions for a class of Friedrichs systems coming from linear transport. Adv. Comput. Math. 46, no. 3, 41, 2020.

[2] G. L. Delzanno, Multi-dimensional, fully-implicit, spectral method for the Vlasov-Maxwell equations with exact conservation laws in discrete form. J. Comput. Phys. 301, 338-356, 2015.

[3] N. R. Mandell, W. Dorland, M. Landreman, Laguerre-Hermite Pseudo-Spectral Velocity Formulation of Gyrokinetics, Journal of Plasma Physics, Volume 84, Issue 1, 2018.

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