From kinetic MHD in stellarators to a fully kinetic description of wave particle interaction

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With the improvement of the stellarator concept and the construction of big machines, the investigation of the interaction between plasma waves and fast particles and its impact on stability becomes more important [1,2].

The description of the particle-wave interaction actually requires a fully kinetic description. It has been shown, however, that often the instabilities can be understood as caused by the interaction between Alfvén-waves characteristic frequencies of the particle motion.

Therefore, a hybrid model is used which describes the main plasma within the ideal MHD model, the interaction with the particles within drift kinetic theory.

It has been shown that within a linearized model of kinetic MHD there is an energy integral [3] which allows the perturbative calculation of the growth rates.

The numerical model, a code called CAS3D-K, is based on the three-dimensional ideal MHD stability code CAS3D [4] and a numeric solution of the drift kinetic equation which avoids approximations to the magnetic geometry but neglects the drifts of the particles away from the flux surface (cf. [5,6]).

The approach is used to discuss stability boundaries in W7-X and W7-AS and considers both, passing and reflected particles. The limits of the applicability of the model will be discussed as well.

It will be shown that gyro-kinetic PIC codes offer a very promising way to improve the model. The two-dimensional linear PIC code GYGLES is used to calculate gyro-kinetic counterparts of ideal MHD modes in cylindrical and in tokamak geometry (GAE, K-MAE, TAE) [8].

[1] A. Weller et al., Phys. Plasmas, **8**, 931 (2001).
[2] K. Toi et al., Nucl. Fusion **44** , 217 (2004).
[3] A. Könies, Phys. Plasmas **7**, 1139 (2000).
[4] C. Nührenberg, Phys. Plasmas **6**, 137 (1998).
C. Nührenberg, Plasma Phys. Control. Fusion **41**, 1055 (1999)
[5] R. Marchand, W. M. Tang, and G. Rewoldt, Phys. Fluids **23** 1164 (1980)
[6] C. Z. Cheng, Phys. Rep. **211**, 1 (1992).
[7] M. Fivaz et al., Comp. Phys. Commun. **11** 27 (1998).
A. Mishchenko, R. Hatzky, A. Könies, Phys. Plasmas **11**, 5480, (2004).
[8] A. Mishchenko, R. Hatzky, A. Könies, submitted to Phys. Plasmas