Evolving background δf method

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A new, time-implicit δf method which is "exactly" energy-conserving is described and illustrated with several numerical examples. This method is based on the earlier stress-closure method described previously [D. C. Barnes, *et al.*, *Phys. Plasmas* **15**, 055702 (2008)]. In contrast to existing tools, this approach admits an exact energy integral, one term of which is the r.m.s. particle weights. Thus, secular growth of the r.m.s. weight is not allowed, and the method remains accurate and valid for all simulation time. We are studying whether the avoidance of aliasing instabilities, shown for energy-conserving full-f PIC [D. C. Barnes and L. Chacón, submitted to *J. Comp Phys.*] offers similar advantages for the present method.

This advance is made practical by adopting the Jacobian-Free Newton-Krylov (JFNK) solution of resulting implicit equations. An additional essential numerical feature is the projection of the weights unto their constraint space. As noted earlier, this method naturally allows orbit averaging, and this is demonstrated in ion-acoustic wave simulations in which electrons are sub-stepped up to 25 times during the main moment time step, which represents an electron plasma frequency CFL number of greater than 4.5.