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Erratum: "Gyrokinetic simulations including the centrifugal force in a rotating tokamak plasma" [Phys. Plasmas 17, 102305 (2010)]

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This erratum reports on an incorrect result presented in Ref. 1 dealing with gyrokinetic simulations including the centrifugal force in a rotating plasma. The formulation of the model used in Ref. 1 is based on the equations derived in Ref. 2, and it has recently been pointed out[3] that the model is missing a term in the radial derivative of the Maxwell distribution, connected with the free energy in the rotation profile. For the case of a strongly rotating plasma with a local rotation gradient, the equations of Ref. 1 should be modified: The Ω appearing in Eqs. (5)–(7) of Ref. 1 should be interpreted as the plasma rotation frequency ω_ϕ, which can have a radial variation (unlike the rotation frequency Ω of the rigidly rotating frame). Since the gyrokinetic equation is formulated in the local limit with the rotation frequency of the rigidly rotating frame (Ω) equal to the plasma rotation (ω_ϕ) at the local surface considered, this difference is important only when radial derivatives are taken. Equation (12) of Ref. 1 then becomes

$$\begin{aligned}\frac{R}{L_n^E} - \frac{R}{L_n}\bigg|_{R_0} = {}& \left(\frac{\partial T_e}{\partial \psi} + \frac{\partial T_i}{\partial \psi}\right)\frac{m_i\Omega^2(R^2 - R_0^2)}{2(T_e + T_i)^2} \\ & - \frac{m_i\Omega^2}{T_e + T_i}\left(R\frac{\partial R}{\partial \psi}\bigg|_\theta - R_0\frac{\partial R_0}{\partial \psi}\bigg|_\theta\right) \\ & + \frac{\partial \omega_\phi}{\partial \psi}\frac{\Omega m_i}{T}(R^2 - R_0^2)\end{aligned} \tag{12}$$

and Eq. (14) of Ref. 1 becomes

$$\begin{aligned}S = - \mathbf{v}_E \cdot \Bigg[& \frac{\nabla n_{R_0}}{n_{R_0}} - \frac{m\Omega^2}{T}R_0\frac{\partial R_0}{\partial \psi}\bigg|_\theta \nabla\psi \\ & + \left(\frac{v_\parallel^2}{v_{\rm th}^2} + \frac{(\mu B + \mathcal{E})}{T} - \frac{3}{2}\right)\frac{\nabla T}{T} \\ & + \left(\frac{m v_\parallel R B_t}{BT} + \frac{m\Omega}{T}[R^2 - R_0^2]\right)\nabla\omega_\phi\Bigg]F_M \\ & - \frac{Ze}{T}\frac{\mathrm{d}\mathbf{X}}{\mathrm{d}t}\cdot\nabla\langle\phi\rangle F_M.\end{aligned} \tag{14}$$

The additional terms given above have recently been implemented in the gyro-kinetic flux tube code GKW.[4,5]

Almost all results presented in Ref. 1 deal with a strongly rotating plasma with no local rotation gradient ($\nabla\omega_\phi = 0$) and, consequently, are not affected by the new terms given above. Only the result in Sec. IV B for the C_u coefficient (Fig. 10) needs to be revisited. This figure is reproduced here including the new terms. It can be seen that the new term has a significant impact on the results; the coefficient C_u changes sign for the ITG case, and is much larger for the TEM case considered. The result shown in the figure

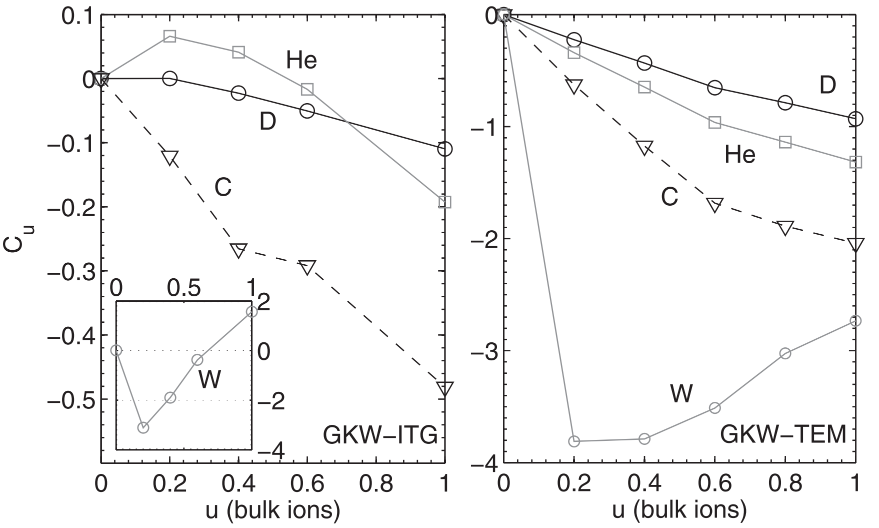

FIG. 10. (Updated) Rotodiffusive coefficient C_u for trace species deuterium, helium, carbon, and tungsten for GKW-ITG and GKW-TEM cases both with $k_\theta\rho_s = 0.304$.

represents the case in which the bulk plasma species have no rotation gradient, but the impurity species is given an independent rotation gradient for calculation of C_u. The convective pinch coefficient C_p is unchanged for this (somewhat unphysical) case. In general, however, the rotation gradient of the bulk plasma species enters in radial derivative of the centrifugal potential Φ and can have a significant influence on C_p (see Refs. 6 and 7). The impurity transport results presented in Ref. 1 therefore describe one specific case and should not be considered to be generic results for ITG or TEM.

The influence of the new terms is significant only for particle and impurity transport. However, it can be seen from the modified Fig. 10 that the difference in impurity transport due to these new terms can be substantial. In general, therefore, the additional radial gradient in the background distribution cannot be neglected for a strongly rotating plasma with a nonuniform angular rotation frequency.

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