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Precession Drift Frequency Benchmarking

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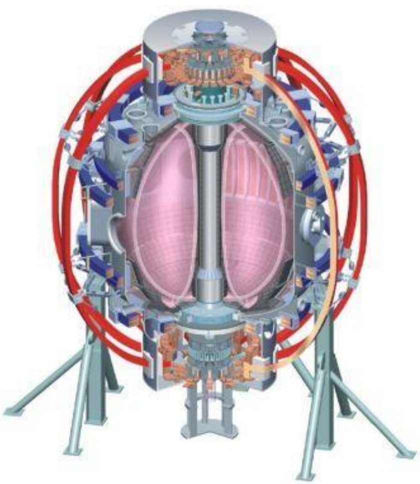

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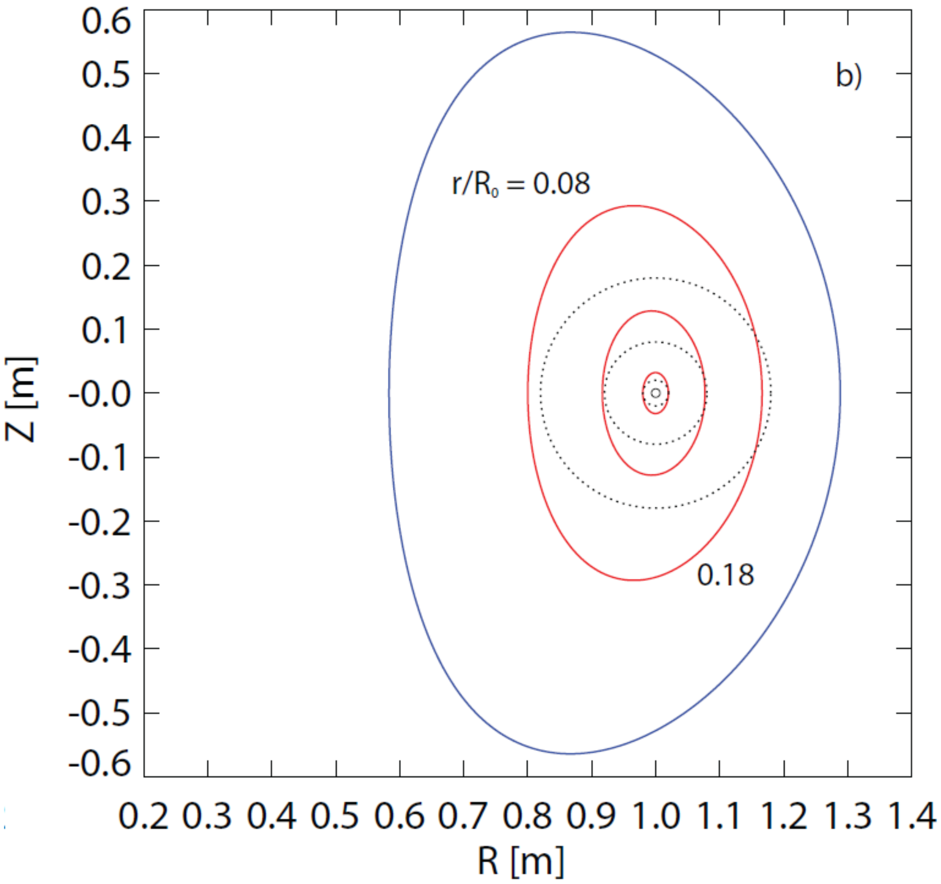
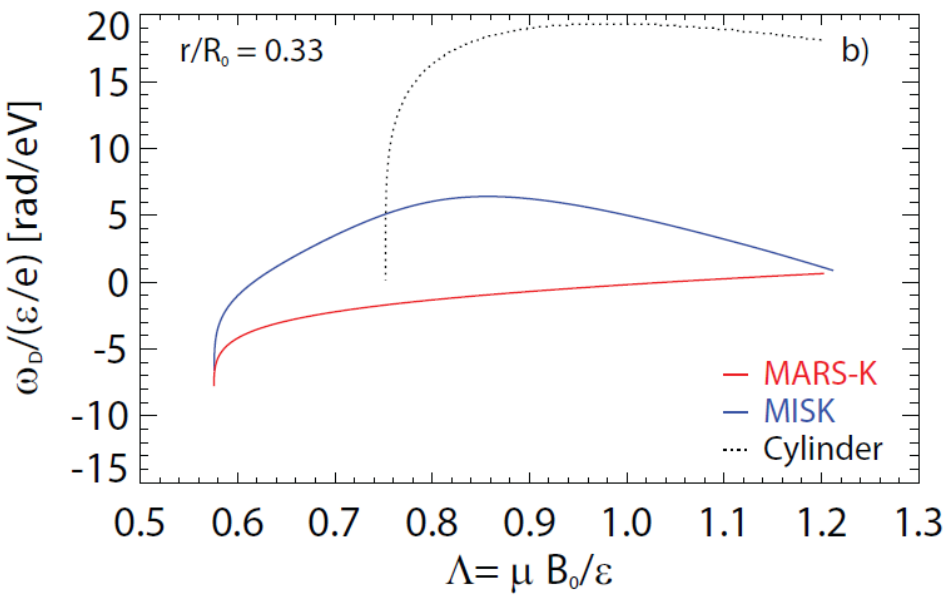
Solov'ev 3 equilibrium





Precession drift frequency

$$\omega_D = -\frac{1}{\tau}\frac{\varepsilon}{Z_j e}\int \frac{d\ell}{v_\parallel}\frac{\Lambda}{B_0}\frac{\partial B}{\partial \Psi} - \frac{1}{\tau}\frac{\varepsilon}{Z_j e}\int \frac{d\ell}{v_\parallel}\left(\frac{2}{B}-\frac{2\Lambda}{B_0}\right)\left(\frac{\partial B}{\partial \Psi}+\frac{\mu_0}{B}\frac{\partial p}{\partial \Psi}\right) - \frac{1}{\tau}\int_{\theta(t)}^{\theta(t')} \hat{q}\, d\theta$$

D_μ D_q

D_B

$$\begin{aligned}
\omega_{B1} &= -\frac{\partial B}{\partial \Psi} \\
&= -\frac{\nabla\Psi\cdot\nabla B^2}{2B|\nabla\Psi|^2} \\
&= -\frac{1}{2B|\nabla\Psi|^2}\left(\nabla\Psi\cdot\nabla\left(\frac{F^2}{R^2}+\frac{\nabla\Psi^2}{R^2}\right)\right) \\
&= -\frac{1}{2B|\nabla\Psi|^2}\left(-\frac{2B^2}{R}\frac{\partial\Psi}{\partial R}+\frac{2F}{R^2}\nabla\Psi\cdot\nabla F+\frac{1}{R^2}\nabla\Psi\cdot\nabla\left(|\nabla\Psi|^2\right)\right)
\end{aligned}$$

$$\omega_{B1\theta} = -\frac{1}{2BR^2}\frac{\nabla\Psi\cdot\nabla\left(|\nabla\Psi|^2\right)}{|\nabla\Psi|^2}$$

MARS and MISK find $\nabla(|\nabla\Psi|^2)$ differently

$$\omega_{B1\theta} = -\frac{1}{2BR^2}\frac{\nabla\Psi\cdot\nabla\left(|\nabla\Psi|^2\right)}{|\nabla\Psi|^2}$$

MARS:

$$\omega_{B1\theta} = -\frac{1}{2BR^2}\frac{1}{|\nabla\Psi|^2}\left(\frac{\partial\Psi}{\partial R}\left(\frac{\partial|\nabla\Psi|^2}{\partial R}\right)+\frac{\partial\Psi}{\partial Z}\left(\frac{\partial|\nabla\Psi|^2}{\partial Z}\right)\right)$$

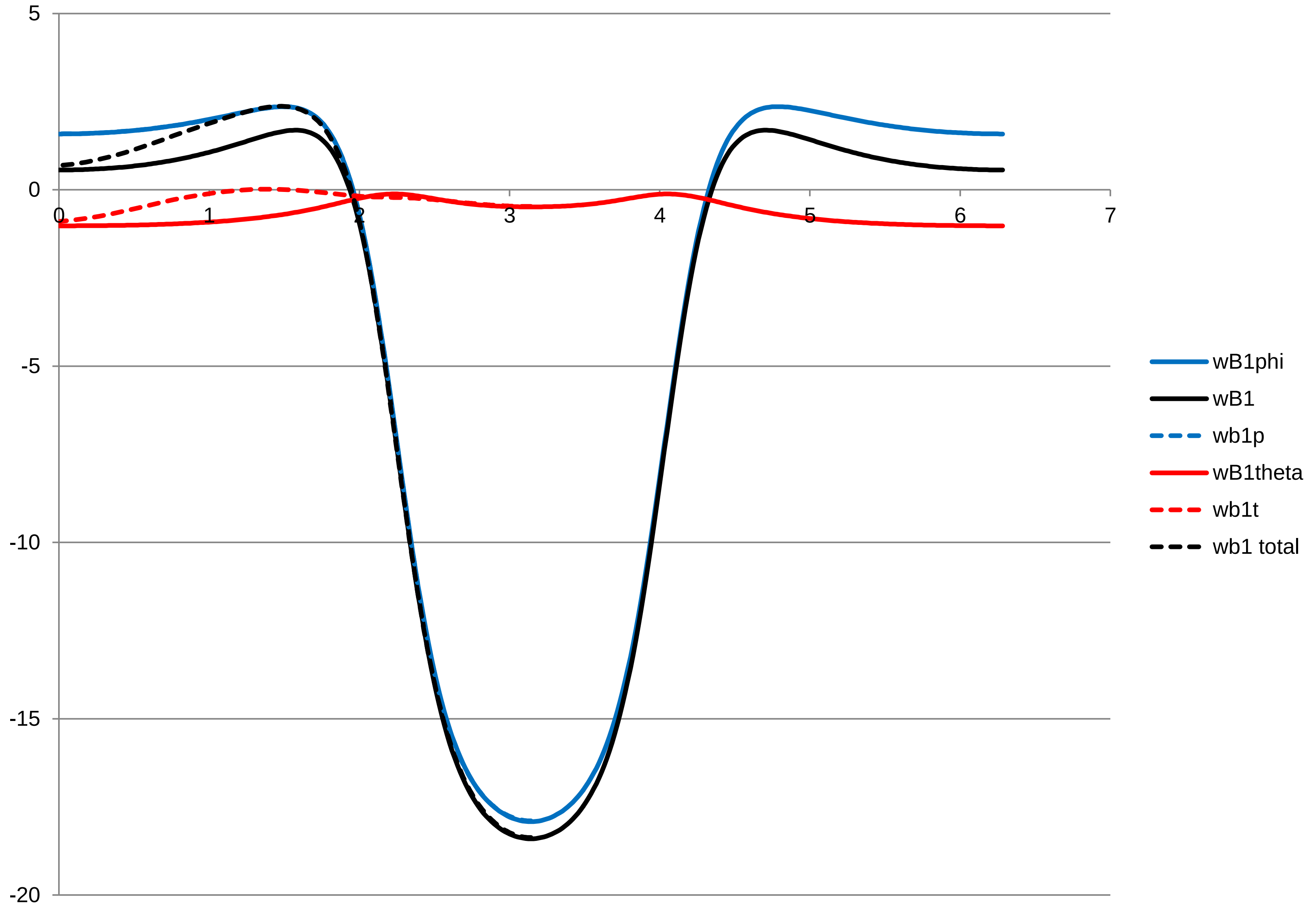
$$= -\frac{1}{2BR^2}\frac{1}{\left(\frac{\partial\Psi}{\partial R}\right)^2+\left(\frac{\partial\Psi}{\partial Z}\right)^2}\left[\frac{\partial\Psi}{\partial R}\frac{\partial}{\partial R}\left(\left(\frac{\partial\Psi}{\partial R}\right)^2+\left(\frac{\partial\Psi}{\partial Z}\right)^2\right)+\frac{\partial\Psi}{\partial Z}\frac{\partial}{\partial Z}\left(\left(\frac{\partial\Psi}{\partial R}\right)^2+\left(\frac{\partial\Psi}{\partial Z}\right)^2\right)\right]$$

MISK:

$$\omega_{B1\theta} = -\frac{1}{2BR^2|\nabla\Psi|^2}\nabla\Psi\cdot\left(\frac{\partial|\nabla\Psi|^2}{\partial\Psi}\nabla\Psi+\frac{\partial|\nabla\Psi|^2}{\partial\theta}\nabla\theta\right)$$

$$= -\frac{1}{2BR^2}\left(\frac{\partial|\nabla\Psi|^2}{\partial\Psi}+\frac{\partial|\nabla\Psi|^2}{\partial\theta}\frac{\nabla\Psi\cdot\nabla\theta}{|\nabla\Psi|^2}\right)$$

$\omega_{B1\theta}$ is different



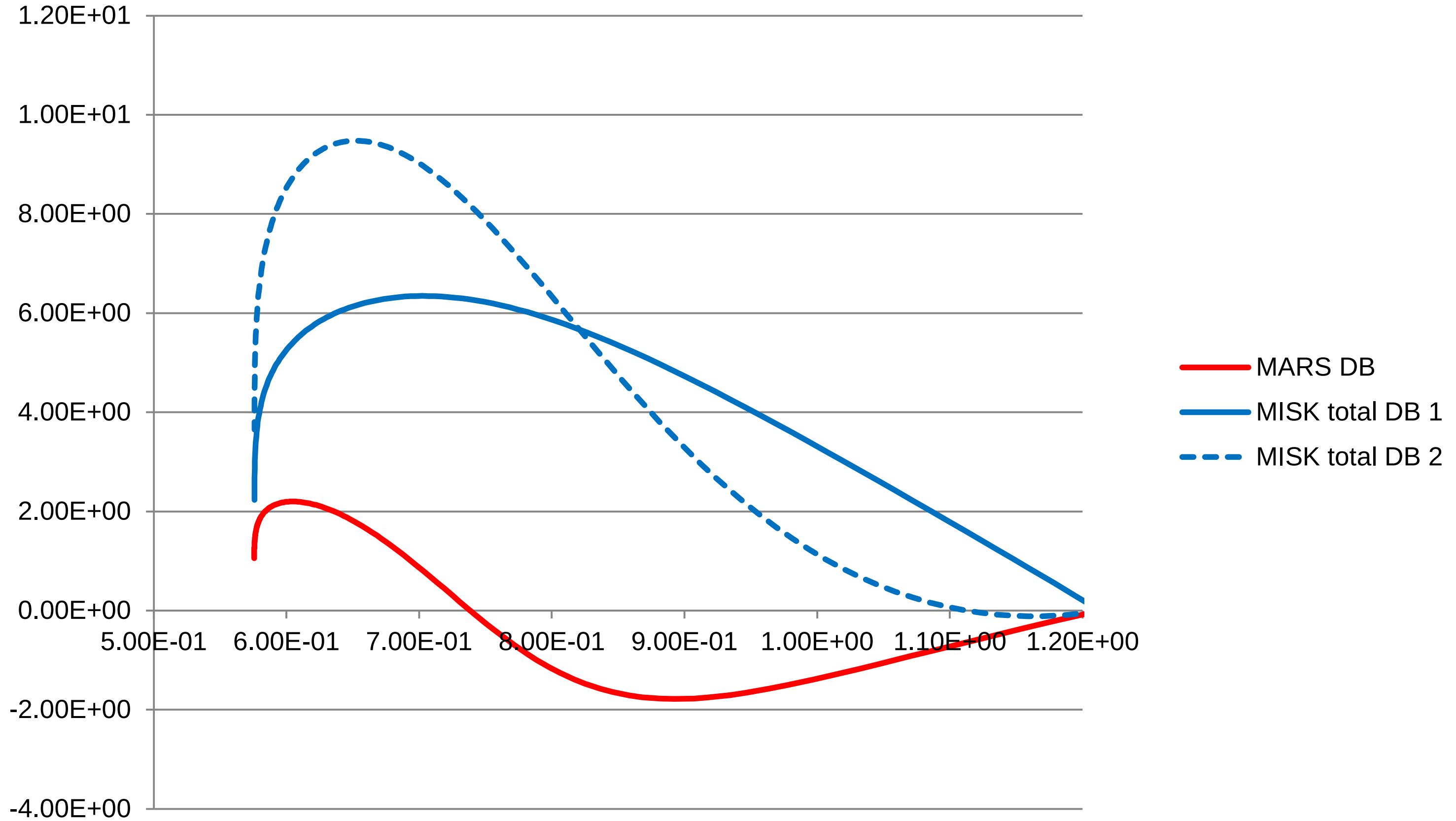
q terms should be the same, but they are not

$$D_{\hat{q}} = \frac{\varepsilon}{Z_j e}\frac{1}{\tau}\int \frac{d\ell}{v_\parallel}\frac{2v_\parallel^2}{v^2}\left[\frac{2}{B}\frac{\partial B}{\partial \Psi} - \frac{1}{B_\theta^2}\frac{\partial B_\theta^2}{\partial \Psi} - \frac{B_\phi^2}{B^2 B_\theta^2}\mu_0\frac{\partial p}{\partial \Psi} - \frac{B_\phi^2}{B_\theta^2}\frac{1}{F}\frac{\partial F}{\partial \Psi}\right] = \frac{1}{\tau}\frac{\varepsilon}{Z_j e}\int_{\theta(t)}^{\theta(t')}\frac{\partial \hat{q}}{\partial \Psi}2R\frac{v_\phi}{v^2}d\theta.$$

Slightly different

↓

Very different!



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