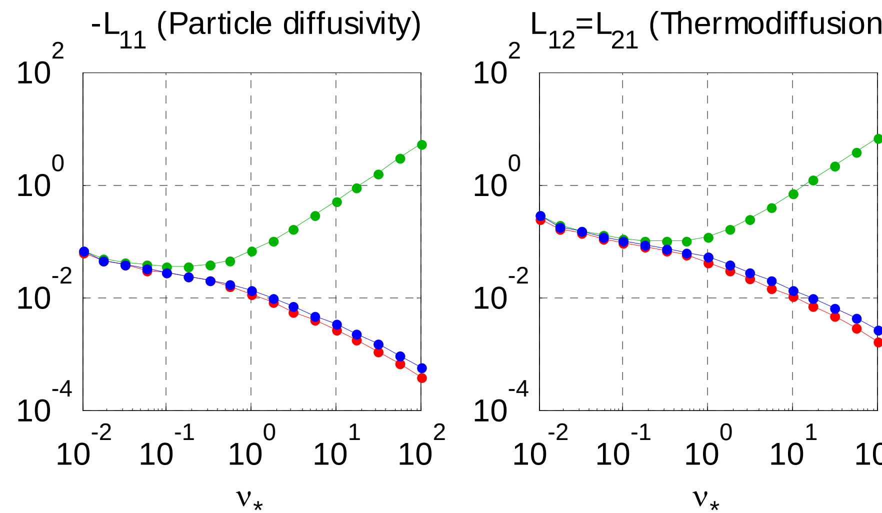
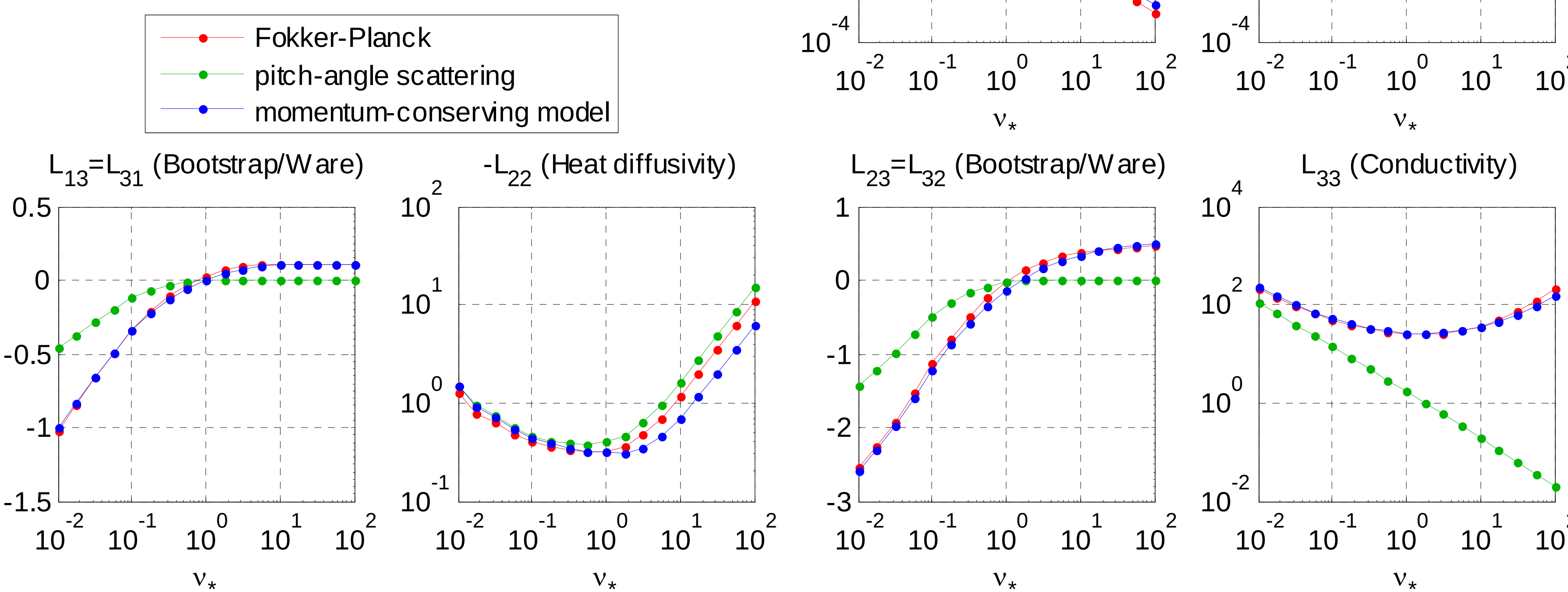
For ion neoclassical physics in LHD, momentum-conserving model collision operator compares well to full Fokker-Planck operator.

$$\begin{pmatrix} \langle \Gamma \cdot \nabla \psi \rangle \\ \langle \mathbf{q} \cdot \nabla \psi \rangle \\ \langle V_\| B \rangle \end{pmatrix} \propto \underbrace{\begin{pmatrix} L_{11} & L_{12} & L_{13} \\ L_{21} & L_{22} & L_{23} \\ L_{31} & L_{32} & L_{33} \end{pmatrix}}_{\text{Transport matrix}} \begin{pmatrix} \dfrac{d \ln p}{d\psi} + \dfrac{e}{T}\dfrac{d\Phi}{d\psi} + \dfrac{d \ln T}{d\psi} \\ \dfrac{d \ln T}{d\psi} \\ \langle E_\| B \rangle \end{pmatrix}$$





$$\nu_* = \nu_{ii} R / \upsilon_{th,i}, \qquad E_r = 0$$

In SFINCS, you can choose between several versions of the drift-kinetic equation

1. "Incompressible" ExB drift, used e.g. in DKES:

$$\left(\upsilon_{\|}\mathbf{b}+\frac{c}{\langle B^2\rangle}\frac{d\Phi}{d\psi}\mathbf{B}\times\nabla\psi\right)\cdot\nabla f_1-\frac{\left(1-\xi^2\right)}{2B}\upsilon\left(\nabla_{\|}B\right)\frac{\partial f_1}{\partial\xi}-C\{f_1\}=-\mathbf{v}_m\cdot\nabla\psi\frac{\partial f_M}{\partial\psi}$$

where $\xi=\upsilon_{\|}/\upsilon$

2. Correct ExB drift:

$$\left(\upsilon_{\|}\mathbf{b}+\frac{c}{B^2}\frac{d\Phi}{d\psi}\mathbf{B}\times\nabla\psi\right)\cdot\nabla f_1-\frac{\left(1-\xi^2\right)}{2B}\upsilon\left(\nabla_{\|}B\right)\frac{\partial f_1}{\partial\xi}-C\{f_1\}=-\mathbf{v}_m\cdot\nabla\psi\frac{\partial f_M}{\partial\psi}$$

3. Including other terms required to conserve μ:

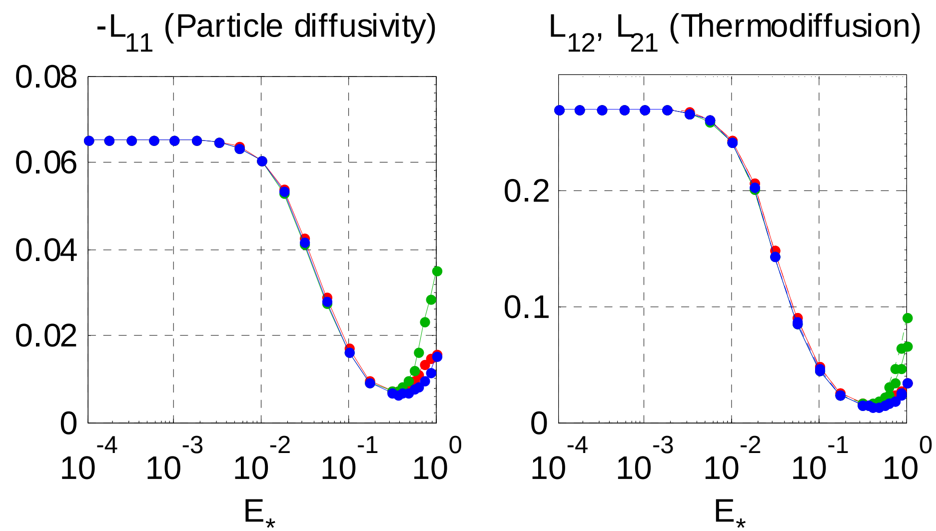
$$\left(\upsilon_{\|}\mathbf{b}+\frac{c}{B^2}\frac{d\Phi}{d\psi}\mathbf{B}\times\nabla\psi\right)\cdot\nabla f_1+\left[-\frac{\left(1-\xi^2\right)}{2B}\upsilon\left(\nabla_{\|}B\right)+\frac{c\xi\left(1-\xi^2\right)}{2B^3}\frac{d\Phi}{d\psi}\mathbf{B}\times\nabla\psi\cdot\nabla B\right]\frac{\partial f_1}{\partial\xi}$$

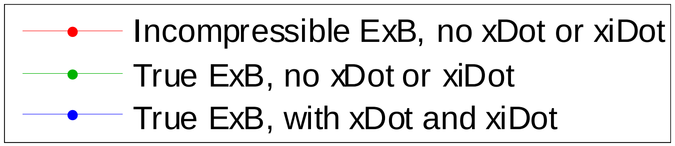
$$+\frac{c\upsilon}{2B^3}\left(1+\xi^2\right)\frac{d\Phi}{d\psi}\left(\mathbf{B}\times\nabla\psi\cdot\nabla B\right)\frac{\partial f_1}{\partial\upsilon}-C\{f_1\}=-\mathbf{v}_m\cdot\nabla\psi\frac{\partial f_M}{\partial\psi}$$

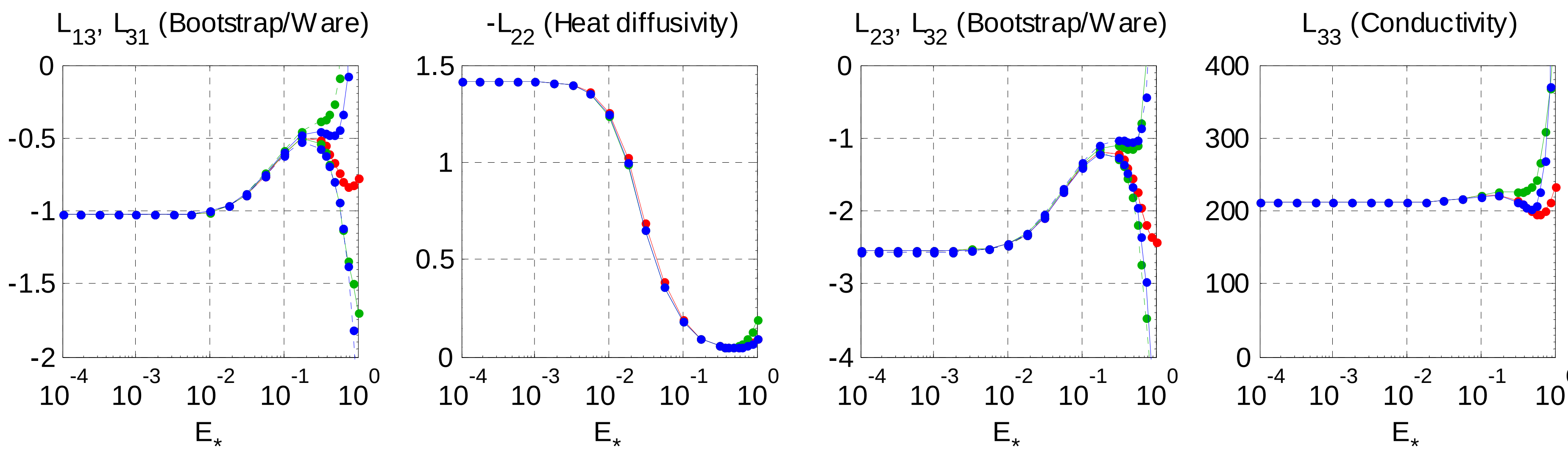
The various options for the E_r terms agree when E_r is well below the resonance, but not near the resonance.

$$\begin{pmatrix}\langle\Gamma\cdot\nabla\psi\rangle\\ \langle\mathbf{q}\cdot\nabla\psi\rangle\\ \langle V_\| B\rangle\end{pmatrix} \propto \underbrace{\begin{pmatrix}L_{11}&L_{12}&L_{13}\\ L_{21}&L_{22}&L_{23}\\ L_{31}&L_{32}&L_{33}\end{pmatrix}}_{\text{Transport matrix}} \begin{pmatrix}\frac{d\ln p}{d\psi}+\frac{e}{T}\frac{d\Phi}{d\psi}+\frac{d\ln T}{d\psi}\\ \frac{d\ln T}{d\psi}\\ \langle E_\| B\rangle\end{pmatrix}$$

(Results for LHD, $\nu_{ii}R/\upsilon_{th}=0.01$.)







$$E_* = E_r cR/(\iota\upsilon RB), \quad \text{so } E_*=1 \text{ is the "resonance."}$$