Henrik's linear eqs

$\frac{\Omega}{2}$ for Kep disk

$$s\,\underline{v}' = 2\Omega\, v_y'\,\hat{\underline{x}} - \frac{\kappa^2}{2\Omega}\, v_x'\,\hat{y} + \frac{\rho'}{\rho^2}\left(\frac{\partial P}{\partial R}\right)\hat{\underline{x}} + \frac{ikB}{4\pi\rho}\,\underline{B}'$$

$$s\,\underline{B}' = ikB\,\underline{v}' - \frac{3}{2}\Omega\, B_x'\,\hat{\underline{y}} - \eta k^2\,\underline{B}'$$

$$s\rho' = \frac{\rho}{\gamma}\frac{\partial S}{\partial R}\, v_x' - \xi k^2 \rho'$$

Divide density eqn by $\frac{\rho}{\gamma}\frac{\partial S}{\partial R}$

$$\Rightarrow \quad s\frac{\rho'}{\frac{\rho}{\gamma}\frac{\partial S}{\partial R}} = V_r' - \xi k^2 \frac{P'}{\frac{\rho}{\gamma}\frac{\partial S}{\partial R}}$$

Define $\quad \theta' \equiv \frac{\rho'}{\frac{\rho}{\gamma}\frac{\partial S}{\partial R}} \Rightarrow \rho' = \frac{\rho}{\gamma}\frac{\partial S}{\partial R}\cdot\theta'$

Pressure term in mom eqn

$$\frac{\rho'}{\rho^2}\frac{\partial P}{\partial R} = \frac{1}{\rho^2}\frac{\partial P}{\partial R}\cdot\frac{\rho}{\gamma}\frac{\partial S}{\partial R}\theta' = \frac{1}{\gamma\rho}\frac{\partial P}{\partial R}\frac{\partial S}{\partial R}\theta'$$

$$= -N_R^2\theta'$$

Eqns so for

$$s\,\underline{V}' = 2\Omega V_y'\,\hat{\underline{x}} - \frac{\Omega}{2} V_x'\,\hat{\underline{y}} - N_R^2\theta'\,\hat{\underline{x}} + ik \frac{B^2}{4\pi\rho}\frac{\underline{B}'}{B}$$

V_A^2

$$s\,\frac{\underline{B}'}{B} = ik\,\underline{V}' - \frac{3}{2}\Omega\frac{B_x'}{B}\,\hat{\underline{y}} - \eta k^2 \frac{\underline{B}'}{B}$$

$$s\,\theta' = V_x' - \xi k^2 \theta'$$

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let $\quad \mathbf{K} = \dfrac{k V_A}{\Omega}$

Normalize velocities by V_A, so $V_x' = \hat{V}_x V_A$

Get

$$\underbrace{\frac{s}{\Omega}}_{\hat{s}}\,\hat{\underline{V}}\,\cancel{V_A} = 2\cancel{\Omega}\,\hat{V}_y\,\cancel{V_A}\,\hat{\underline{x}} - \frac{\cancel{\Omega}}{2}\hat{V}_x\,\cancel{V_A}\,\hat{\underline{y}}$$

$$- N_R^2\frac{\theta'}{\Omega V_A}\hat{\underline{x}} + \frac{iK\cancel{\Omega}}{\cancel{V_A}}\cdot\cancel{V_A}\,\frac{\underline{B}'}{B}$$

$$\Rightarrow \quad \hat{s}\,\hat{\underline{V}} = 2\hat{V}_y\,\hat{\underline{x}} - \frac{1}{2}\hat{V}_x\,\hat{\underline{y}} - \frac{N_R^2}{\Omega^2}\frac{\Omega\theta'}{V_A}\hat{\underline{x}} + iK\,\hat{\underline{b}}$$

$$\hat{\underline{b}} = \frac{\underline{B}'}{B}$$

$$\frac{s}{\Omega}\hat{\underline{b}} = \frac{iK\cancel{\Omega}}{V_A}\underline{V}' - \frac{3}{2}\cancel{\Omega}\,\hat{b}_x\,\hat{\underline{y}} - \frac{\eta K^2\Omega^{\cancel{2}}}{V_A^2}\hat{\underline{b}}$$

$$\Rightarrow \quad \hat{s}\,\hat{\underline{b}} = iK\hat{\underline{V}} - \frac{3}{2}\hat{b}_x\,\hat{\underline{y}} - \left(\frac{\eta\Omega}{V_A^2}\right)K^2\,\hat{\underline{b}}$$

But $\quad \Lambda \equiv \dfrac{V_A^2}{\eta\Omega}$

$$\hat{s}\,\Omega\,\frac{\theta'}{V_A} = \hat{V}_x \cancel{V_A} - \frac{\xi K^2 \Omega^2}{V_A^2}\,\frac{\theta'}{V_A}$$

let $\hat{\theta} = \dfrac{\Omega\theta'}{V_A}$

$$\Rightarrow \hat{s}\,\hat{\theta} = \hat{V}_x - \left(\frac{\xi\Omega}{V_A^2}\right) K^2 \hat{\theta}$$

Define $q = \dfrac{\xi}{\zeta} \Rightarrow \dfrac{\xi\Omega}{V_A^2} = q\,\dfrac{\zeta\Omega}{V_A^2} = \dfrac{q}{\Lambda}$

Find dimensionless eqns, drop ^

$$s\,\underline{v} = 2v_y\,\hat{\underline{x}} - \frac{1}{2}v_x\,\hat{\underline{y}} - \left(\frac{N_R^2}{\Omega^2}\right)\theta\,\hat{\underline{x}}$$

$$s\,\underline{b} = iK\,\underline{v} - \frac{3}{2}b_x\,\hat{\underline{y}} - \frac{K^2}{\Lambda}\,\underline{b}$$

$$s\,\theta = v_x - \frac{qK^2}{\Lambda}\,\theta$$