A theoretical tool for the study of radial velocities in the atmospheres of roAp stars

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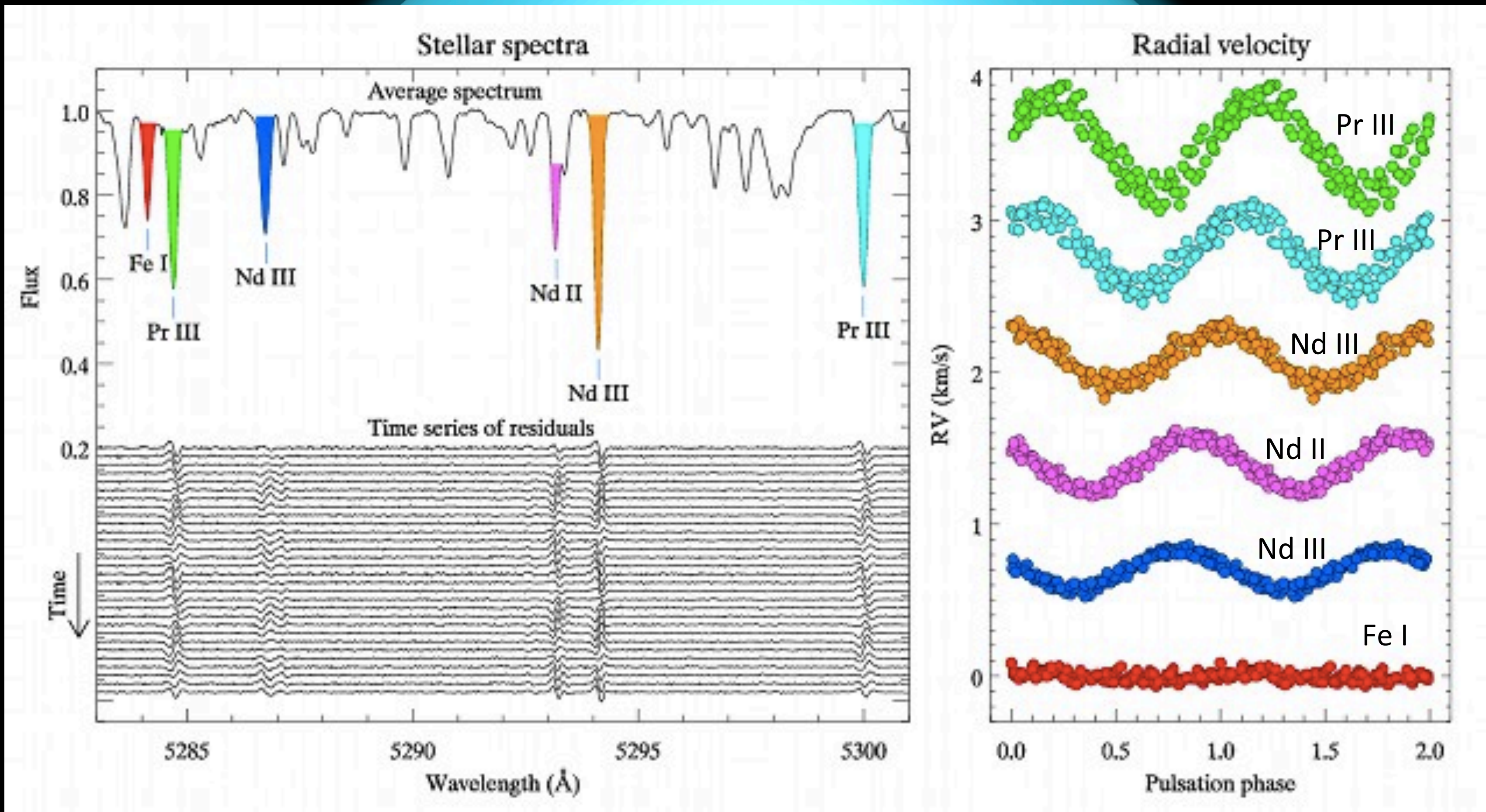


http://www.astro.uu.se/~oleg/research.html

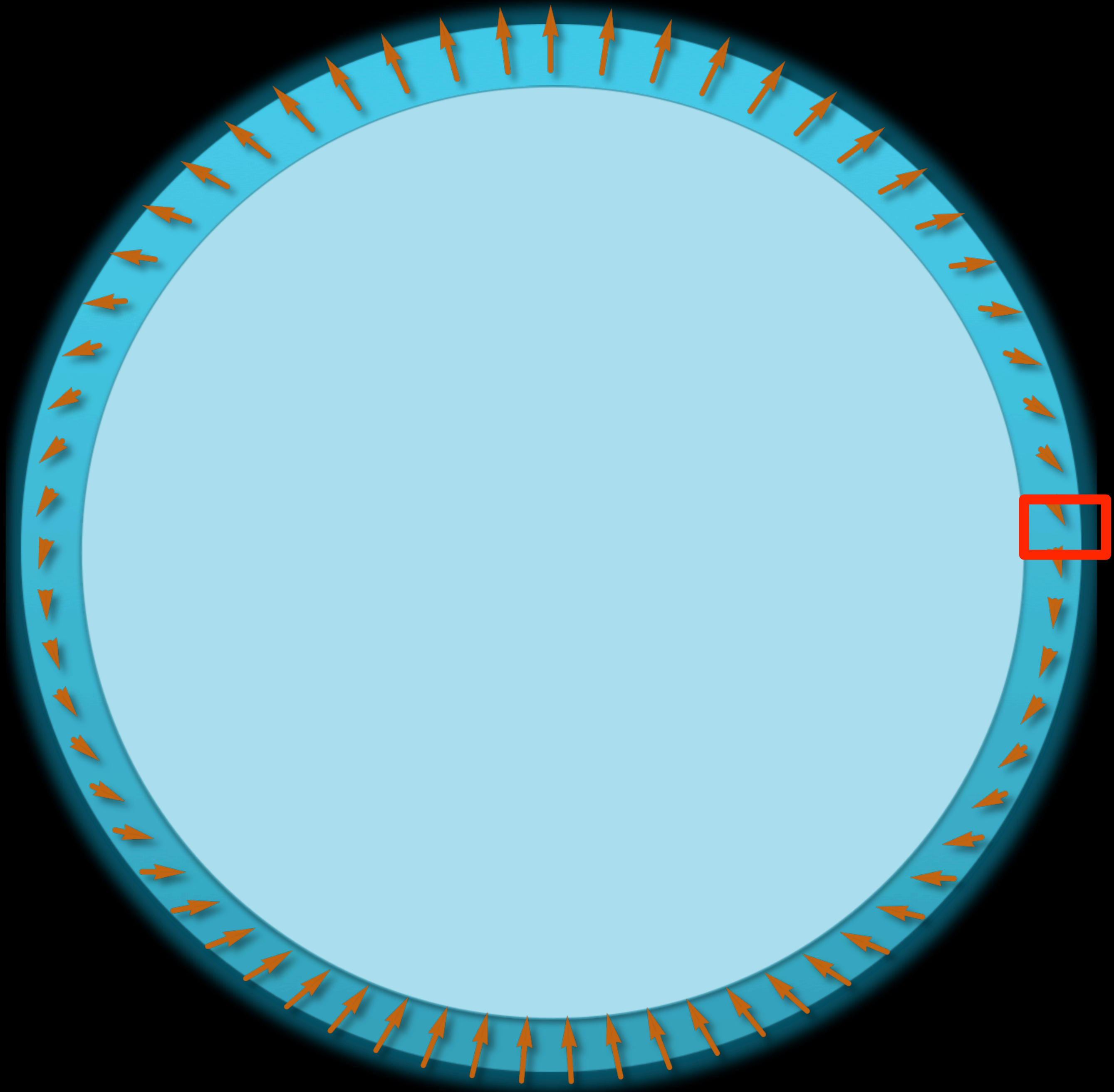
Oscillation Model:

$$\frac{D\rho}{Dt} + \rho\nabla\cdot\vec{v} = 0$$

$$\rho\frac{D\vec{v}}{Dt} = -\nabla p + \rho\vec{g} + \vec{j}\times\vec{B}$$

$$\frac{Dp}{Dt} = \frac{\gamma p}{\rho}\frac{D\rho}{Dt}$$

$$\frac{\partial\vec{B}}{\partial t} = \nabla\times(\vec{v}\times\vec{B})$$

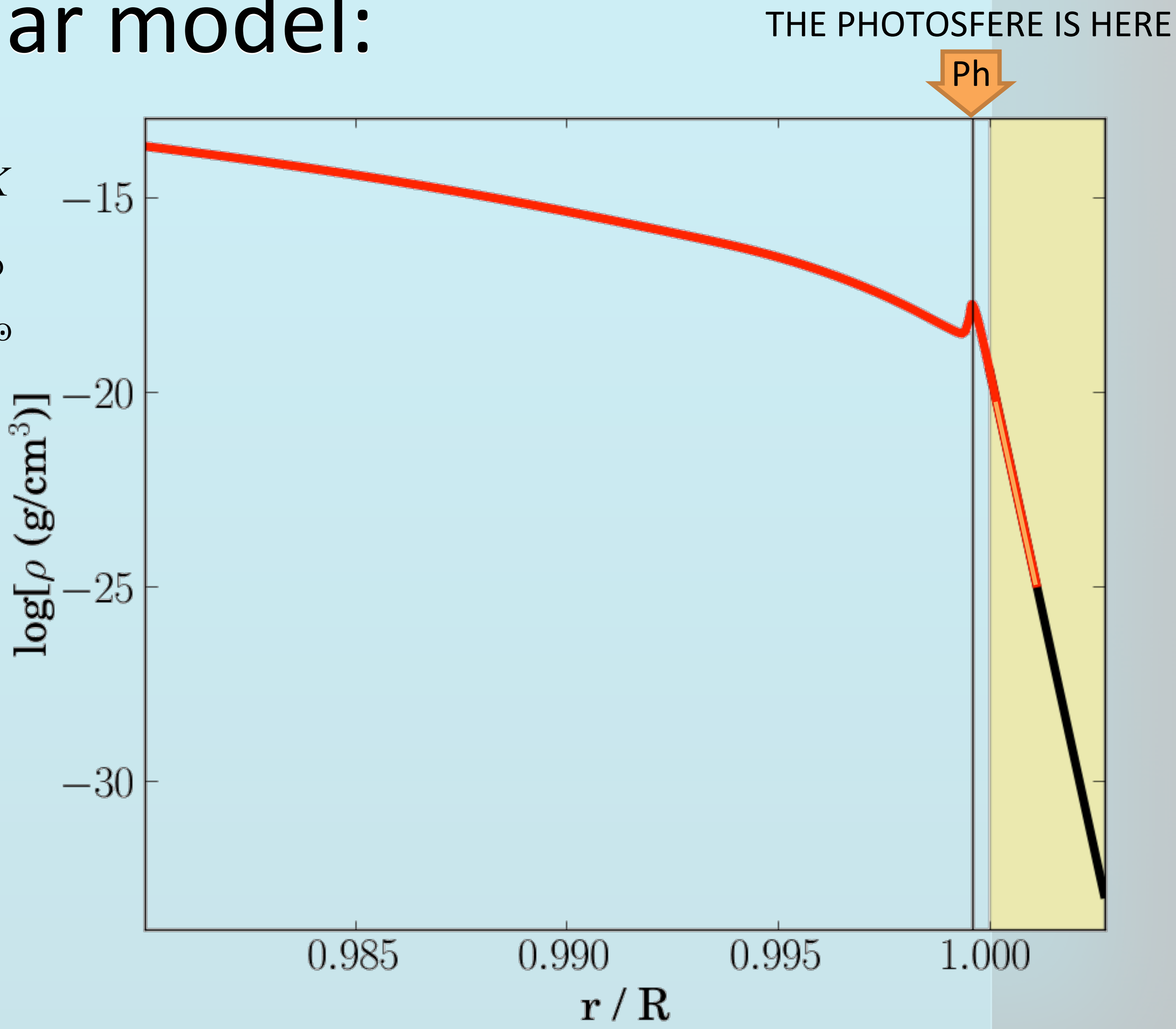


Stellar model:

$$T_{eff} = 8363\ K$$

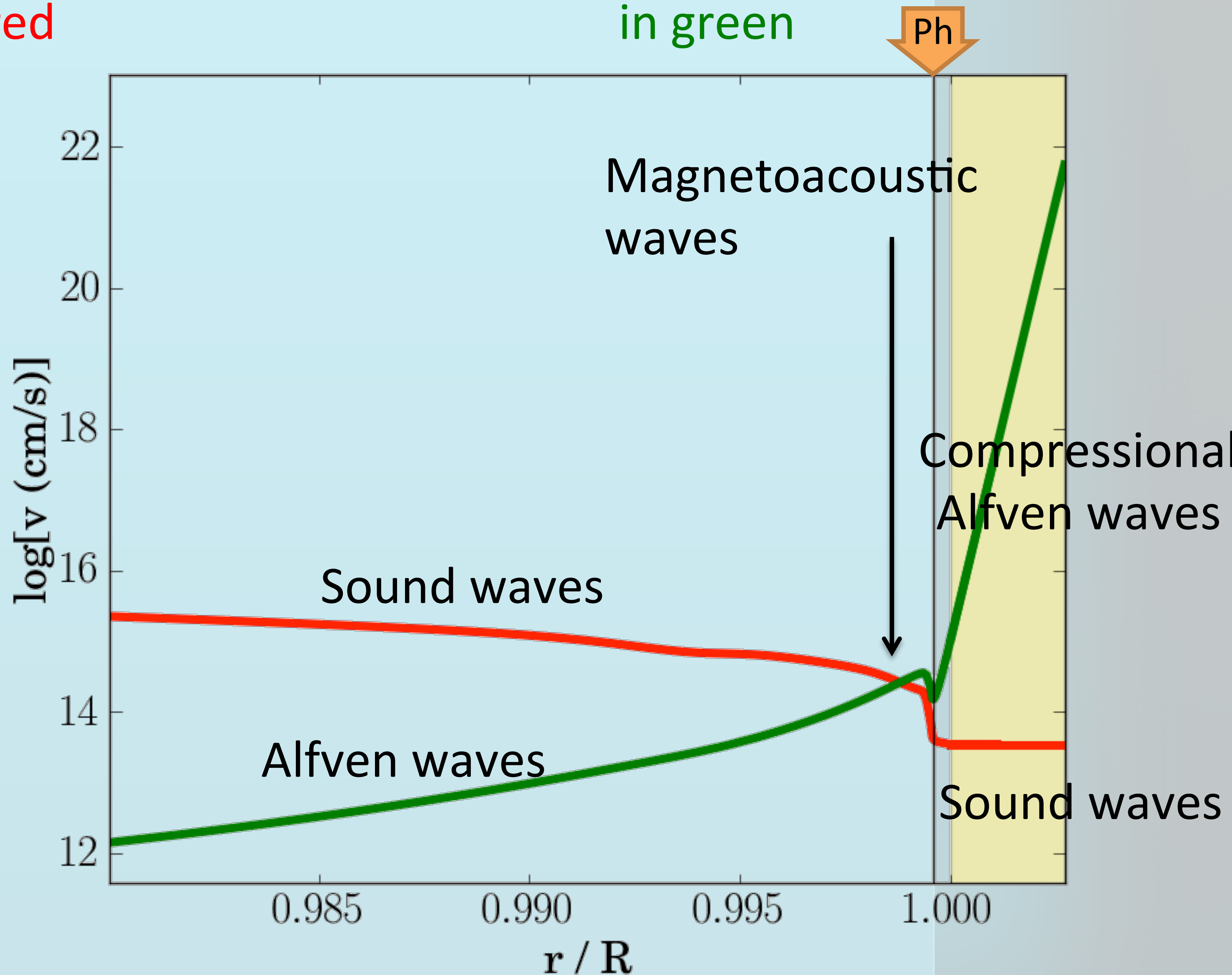
$$M = 1.8\ M_{\odot}$$

$$R = 1.57\ R_{\odot}$$



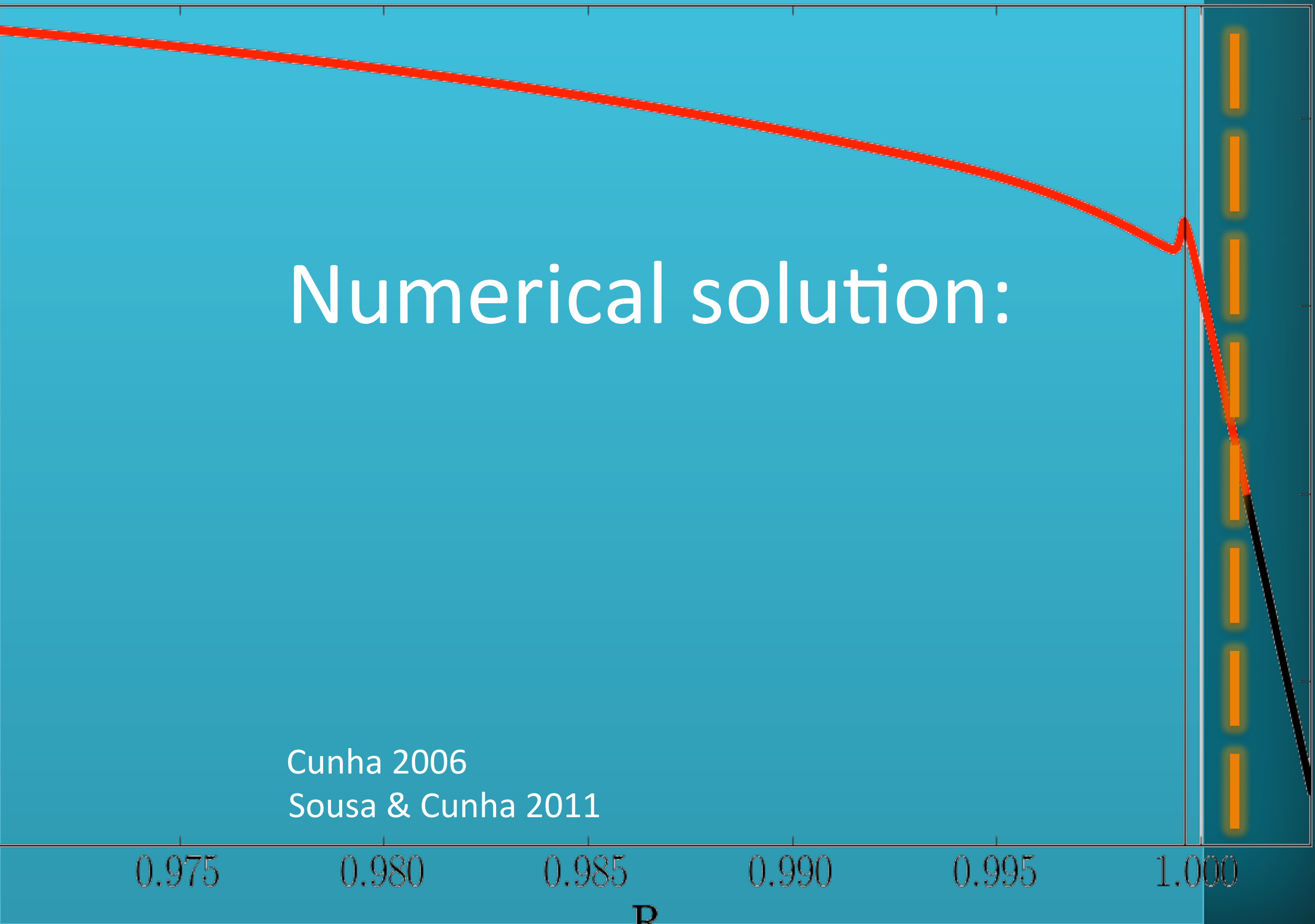
Sound velocity vs Alfven velocity

in red in green



B = 1kG

Calculation of the oscillation solutions:



Numerical solution:

Analytical solution:

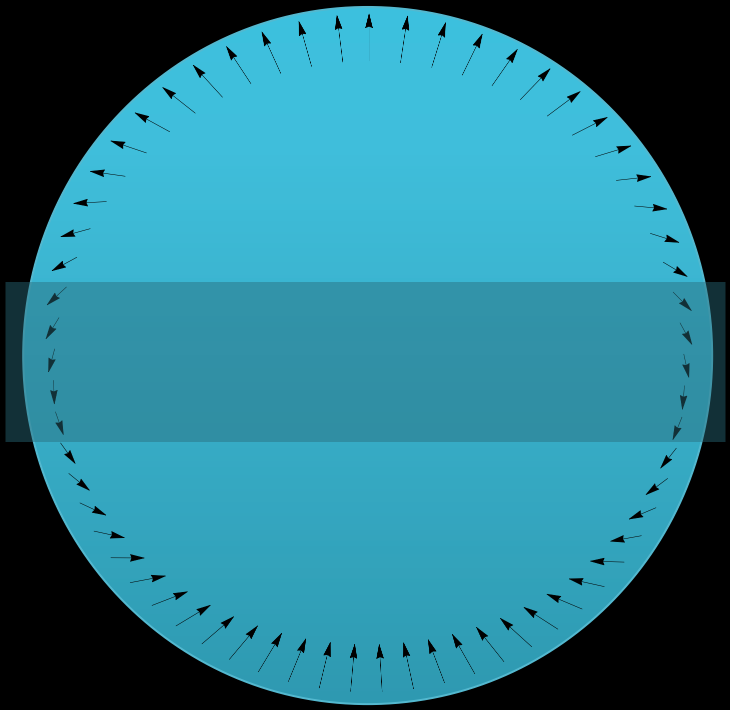
Cunha 2006
Sousa & Cunha 2011

Analytical solutions:

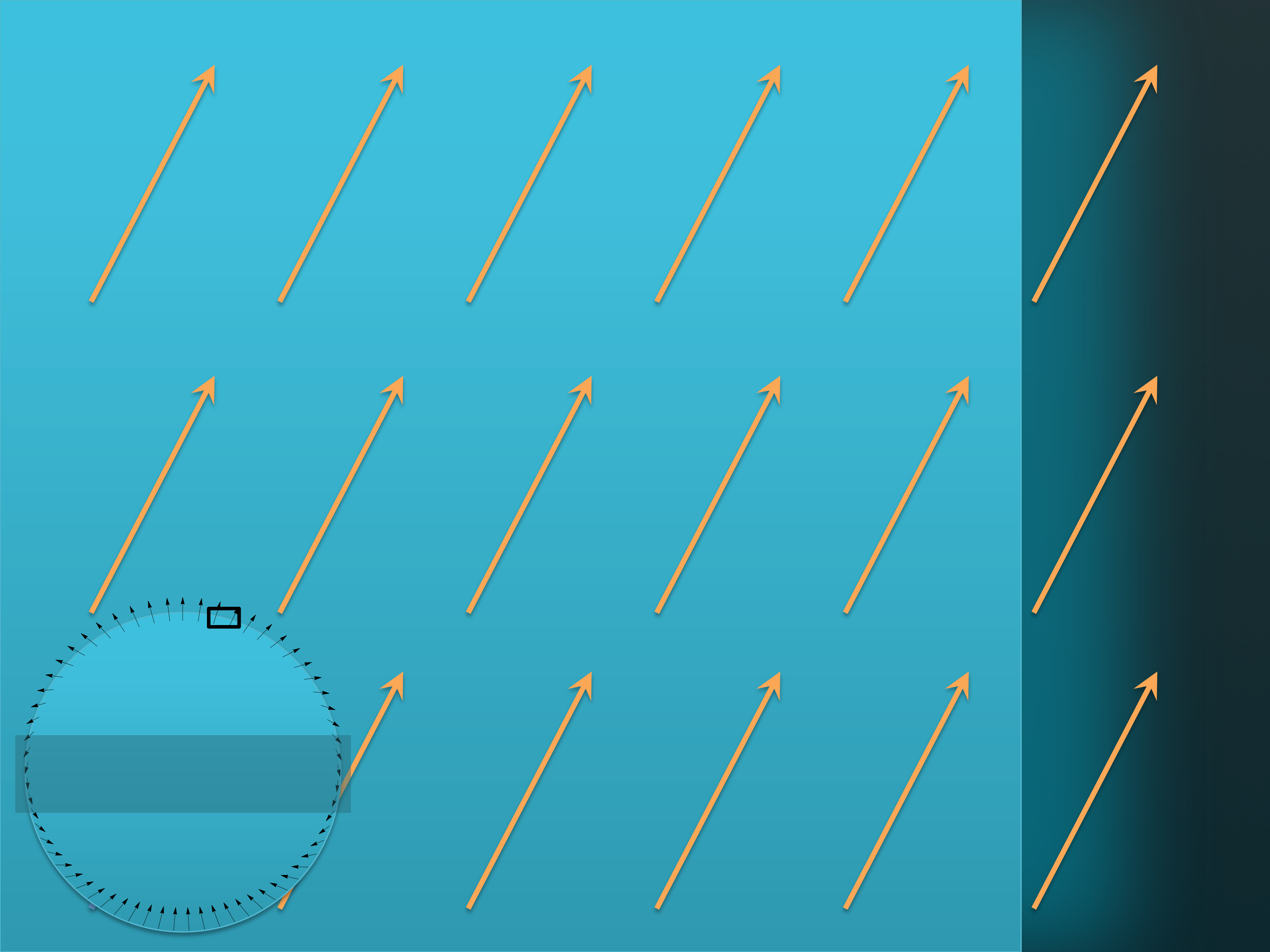
$$\xi_{\perp} = A_f J_0(v_{Alfen})\exp\left[i(\sigma t + \phi_f)\right]$$

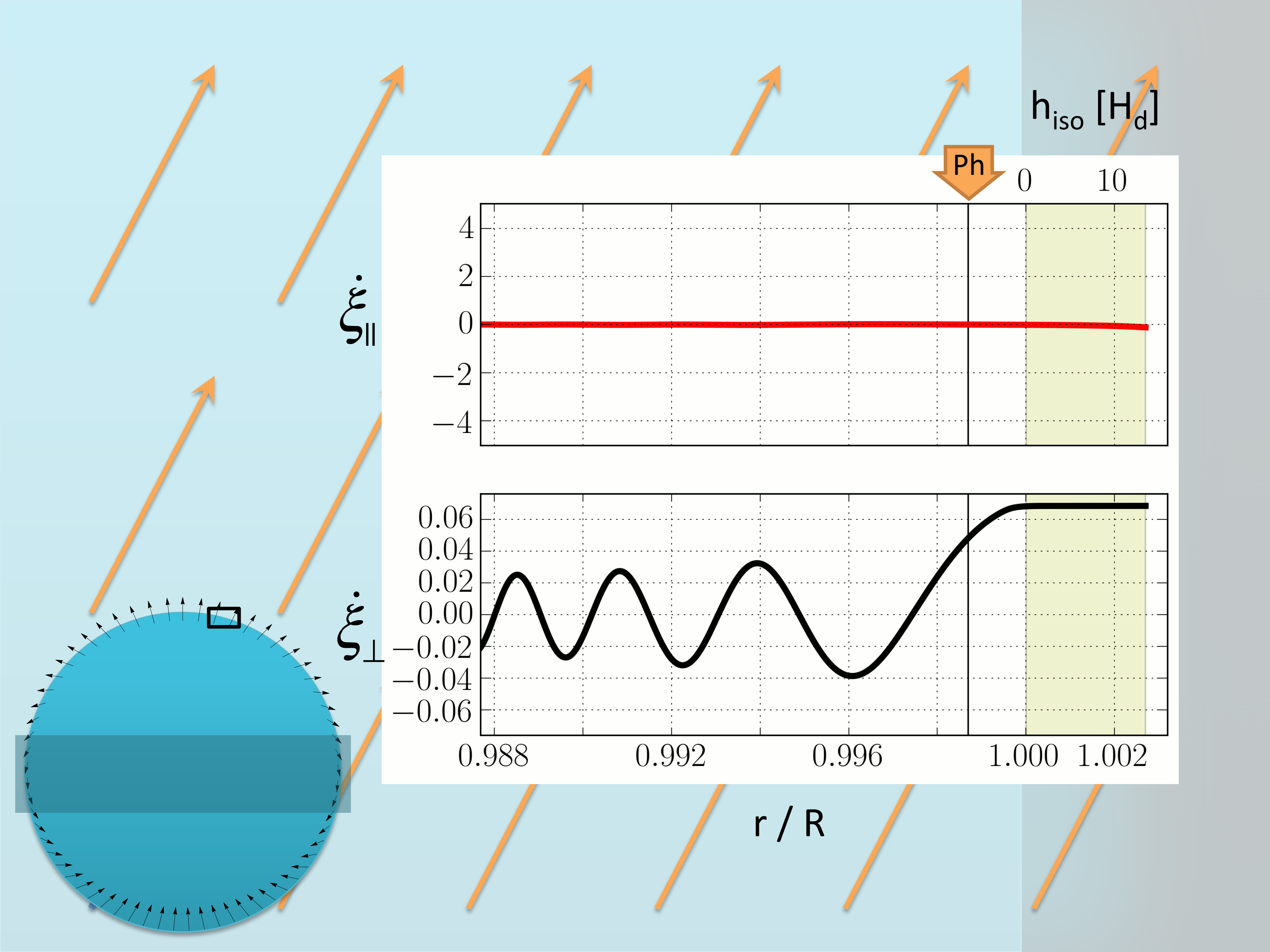
$$\xi_{\parallel} = \frac{A_s \exp\left[k_{\parallel} h\right]}{p^{1/2}}\exp\left[i(\sigma t + \phi_s)\right]$$

$$\xi_{\parallel} = \frac{A_s}{p^{1/2}}\exp\left[i(-k_{\parallel} h + \sigma t + \phi_s)\right]$$

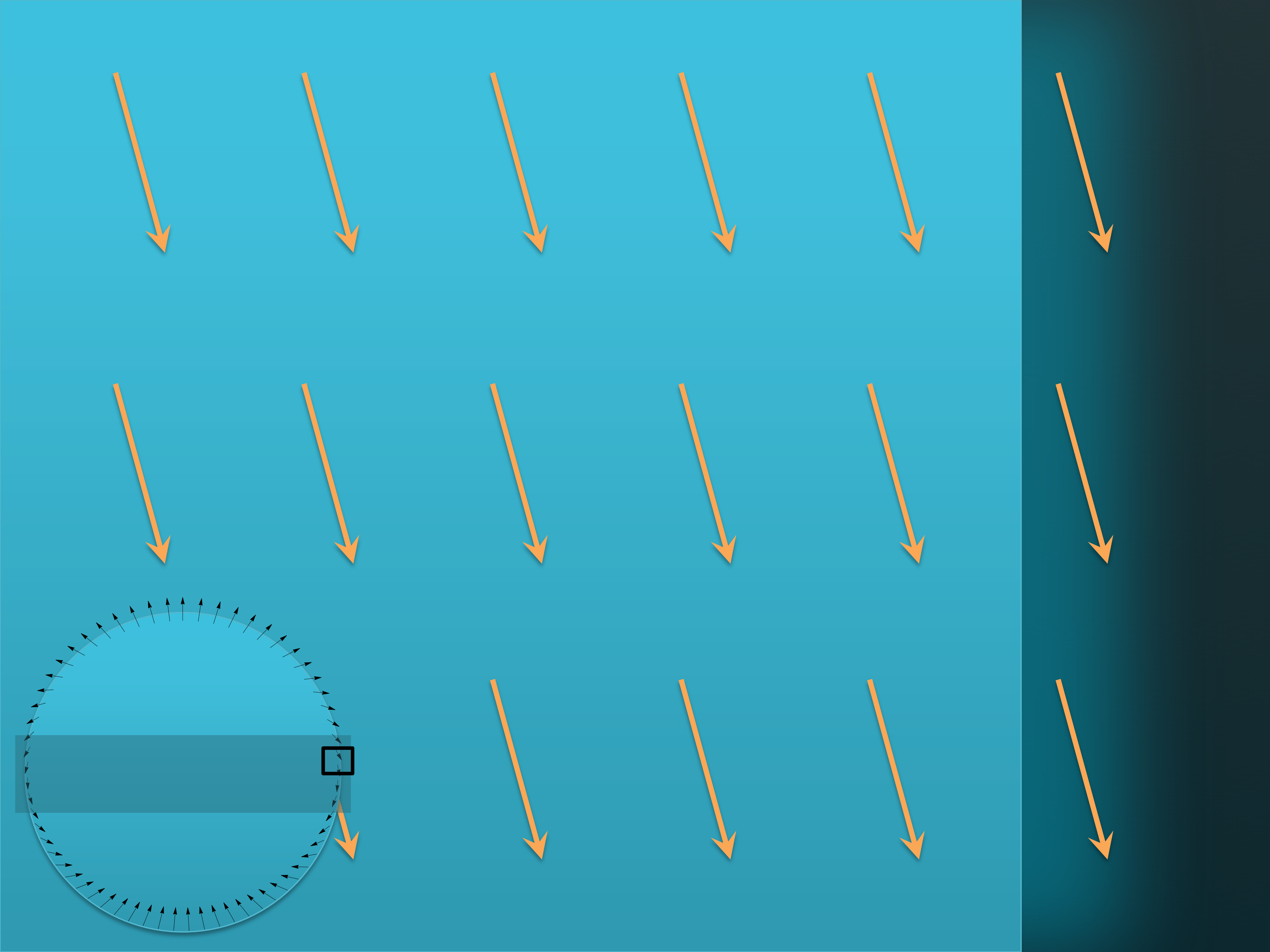


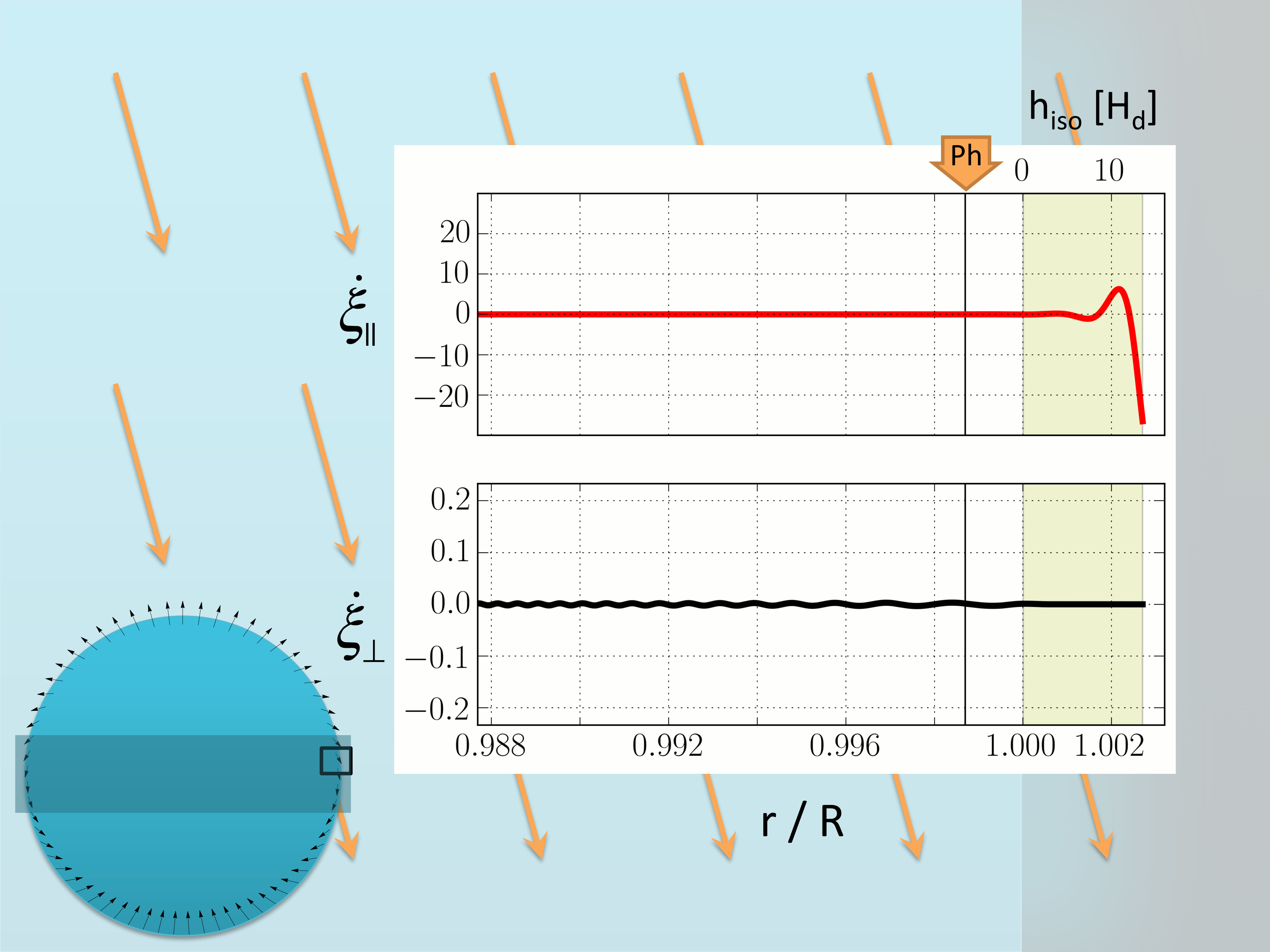
Sousa & Cunha 2011



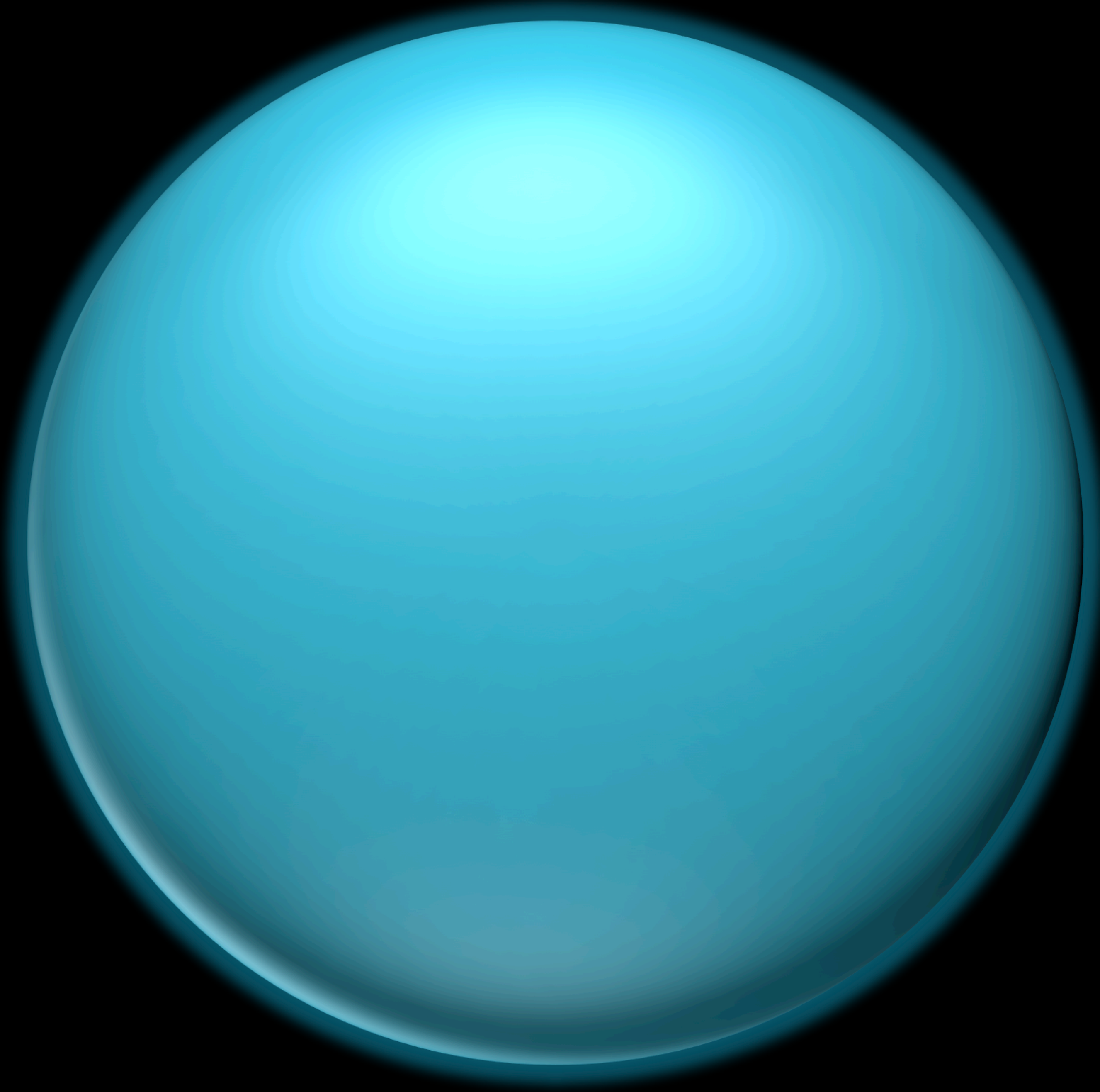


h_{iso} [H_d]
Ph
0
10
4
2
0
−2
−4
$\dot{\xi}_{\parallel}$
0.06
0.04
0.02
0.00
−0.02
−0.04
−0.06
$\dot{\xi}_{\perp}$
0.988
0.992
0.996
1.000
1.002
r / R



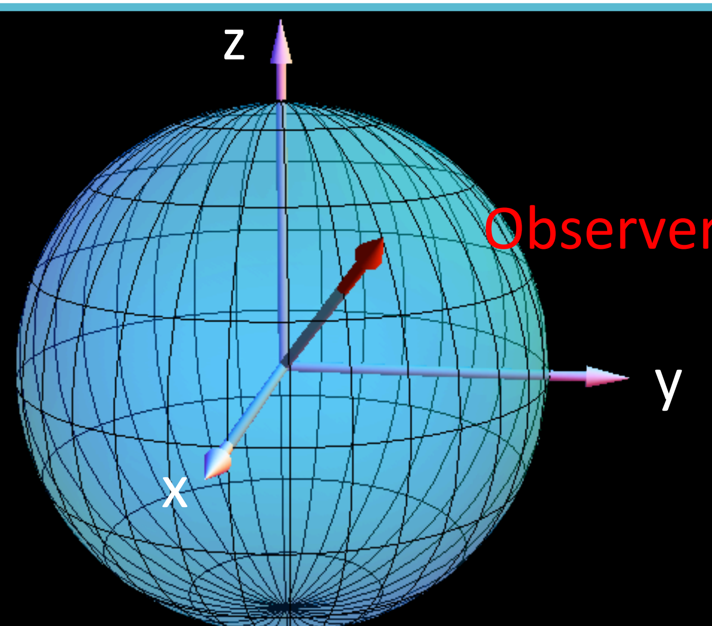


h_{iso} [H_d]
Ph
0
10
20
10
0
−10
−20
$\dot{\xi}_{\parallel}$
0.2
0.1
0.0
−0.1
−0.2
$\dot{\xi}_{\perp}$
0.988
0.992
0.996
1.000
1.002
r / R



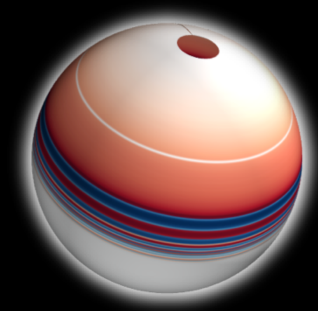
Integrated radial velocity

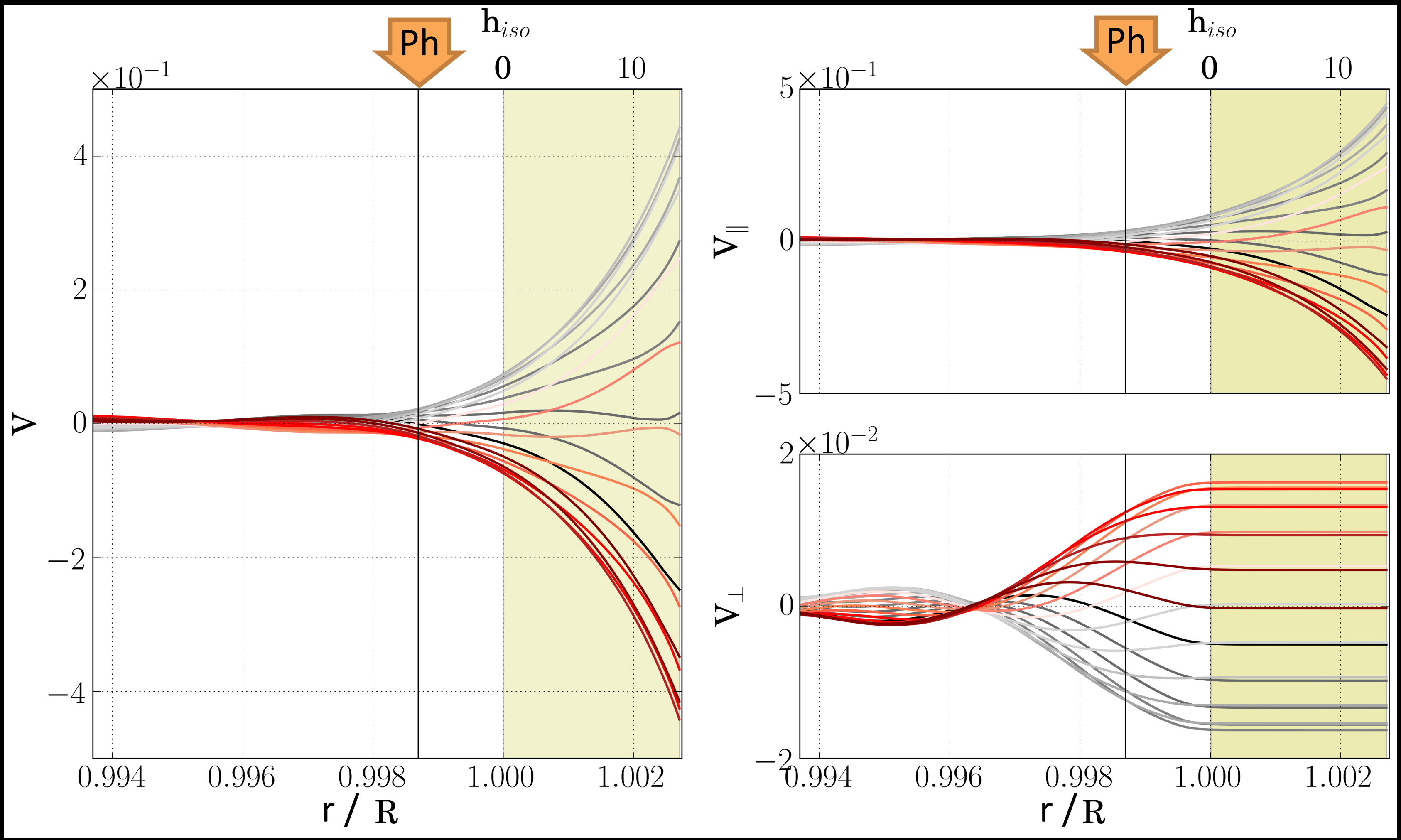
$$V_{\text{int}} = \int_{\varphi_i}^{\varphi_f} \int_{\theta_i}^{\theta_f} \left[V_z X_z + V_x X_x \right] \cdot \frac{1}{C_n} (1 - a(1 - \cos\theta')) \cos\theta \sin\theta \; d\theta d\varphi$$



Integrated Radial Velocity

Frequency = 1.70mHz -- l = 1 -- pole-on





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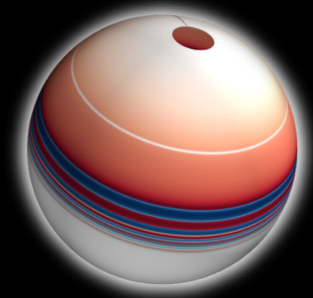

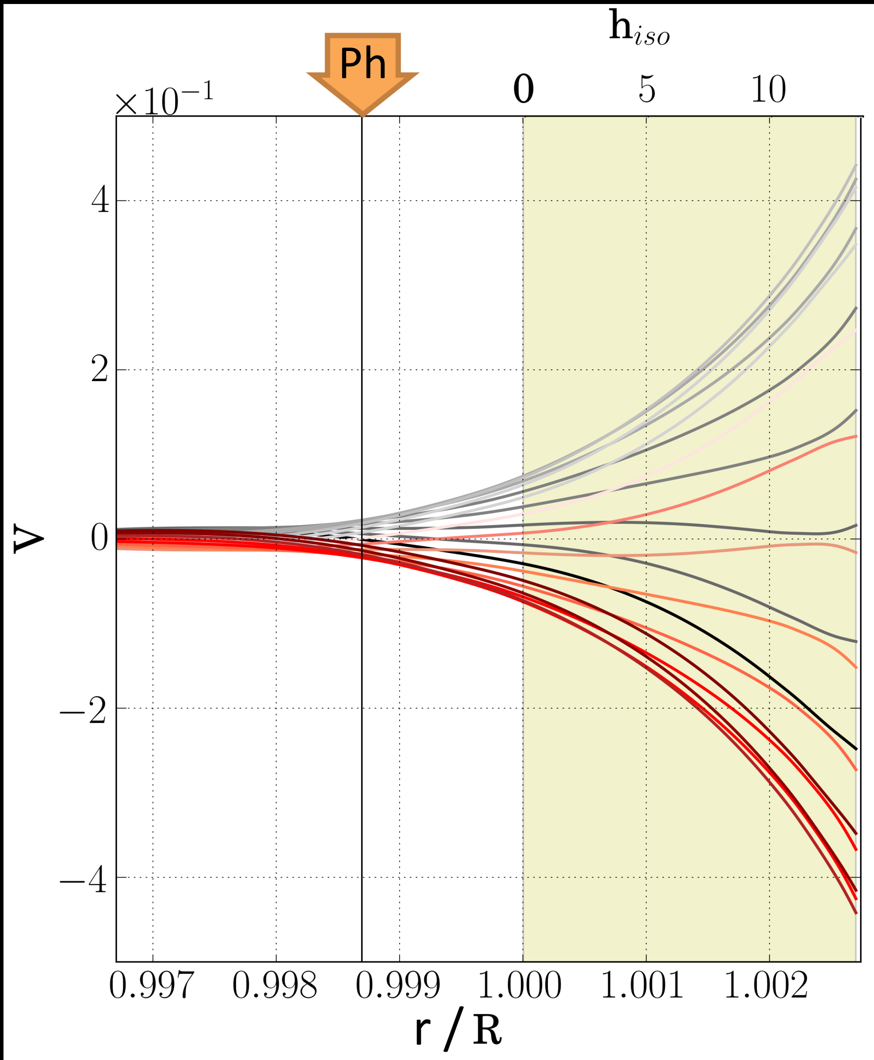

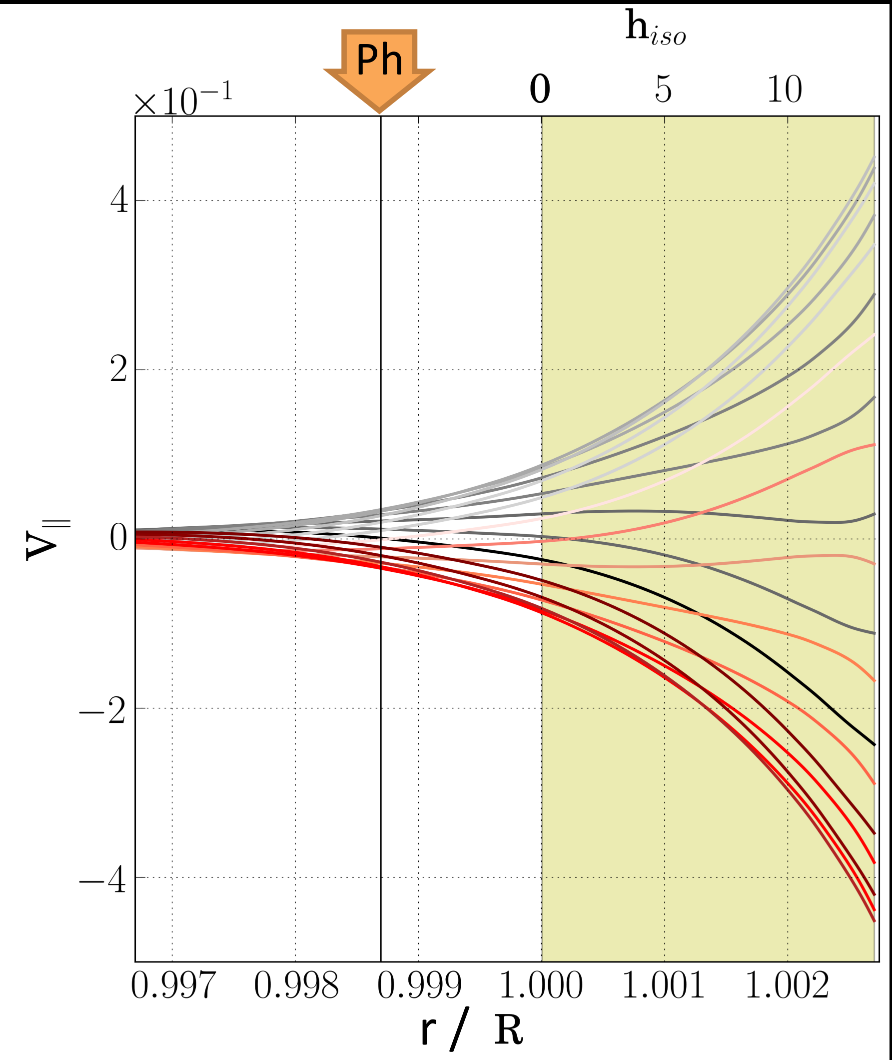

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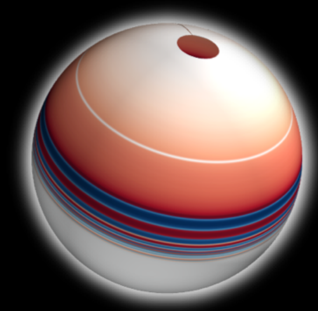
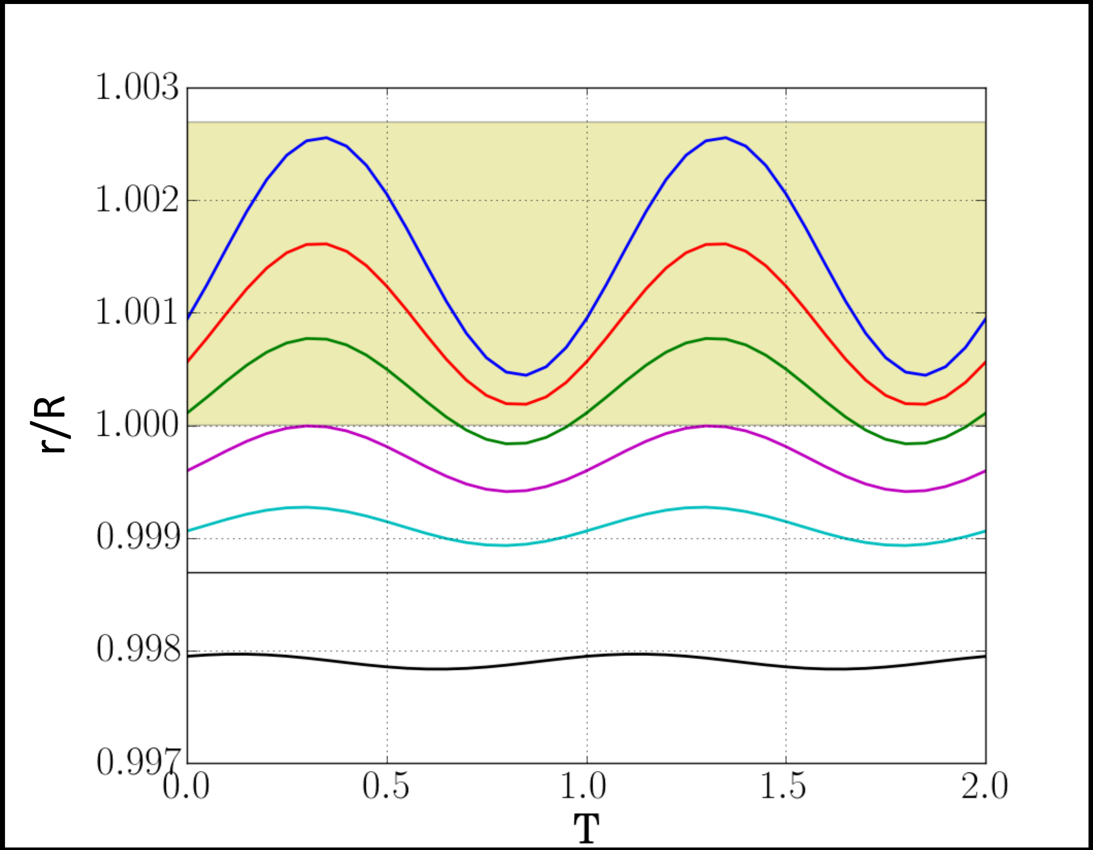
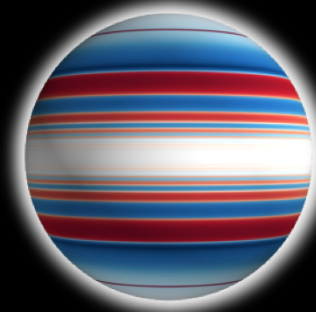
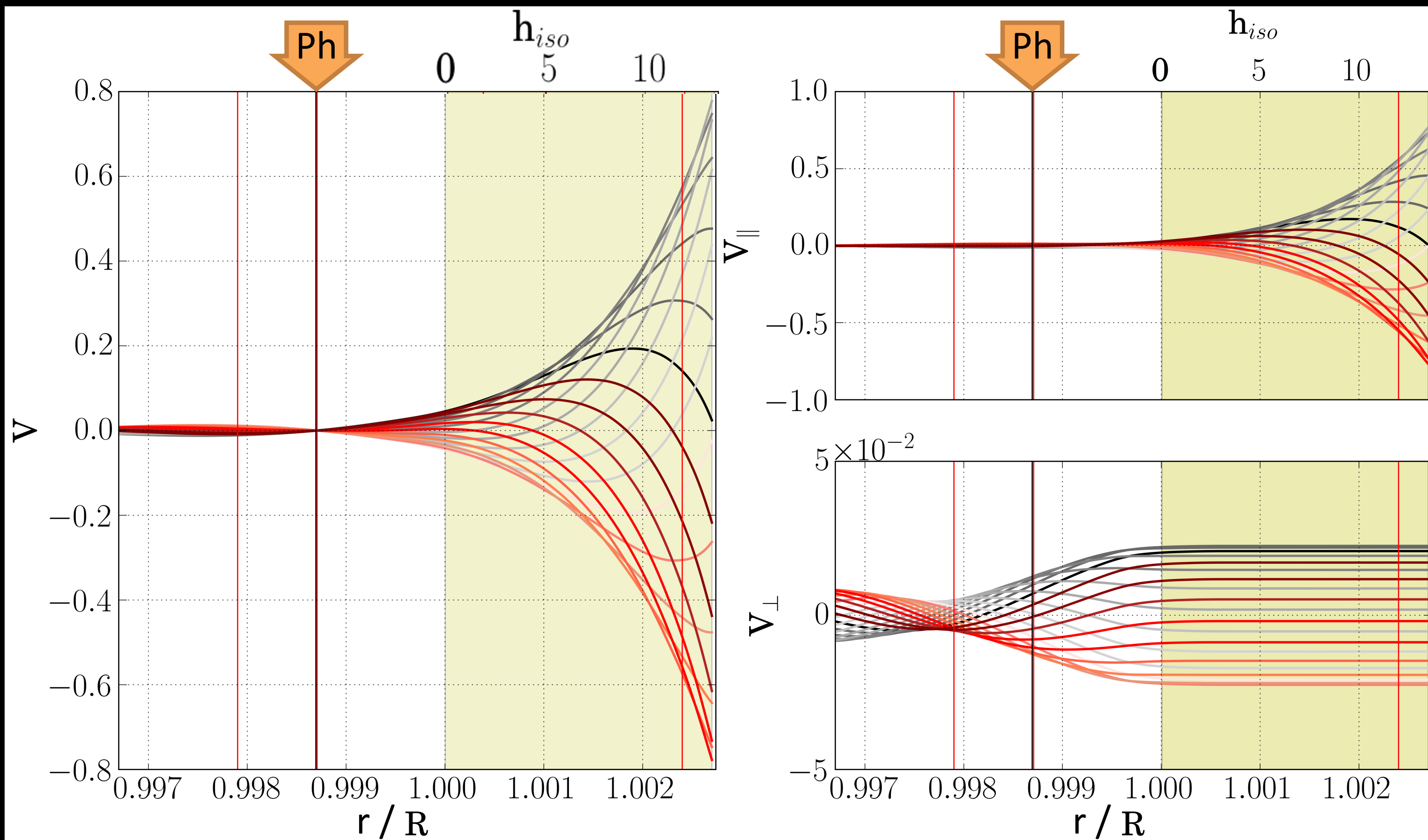




Integrated Radial Velocity

Frequency = 2.22mHz -- l = 2 -- equator-on





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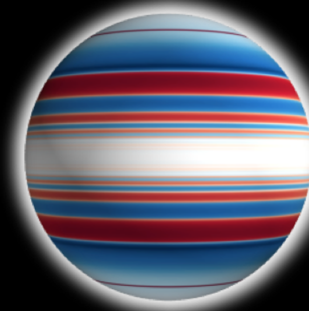
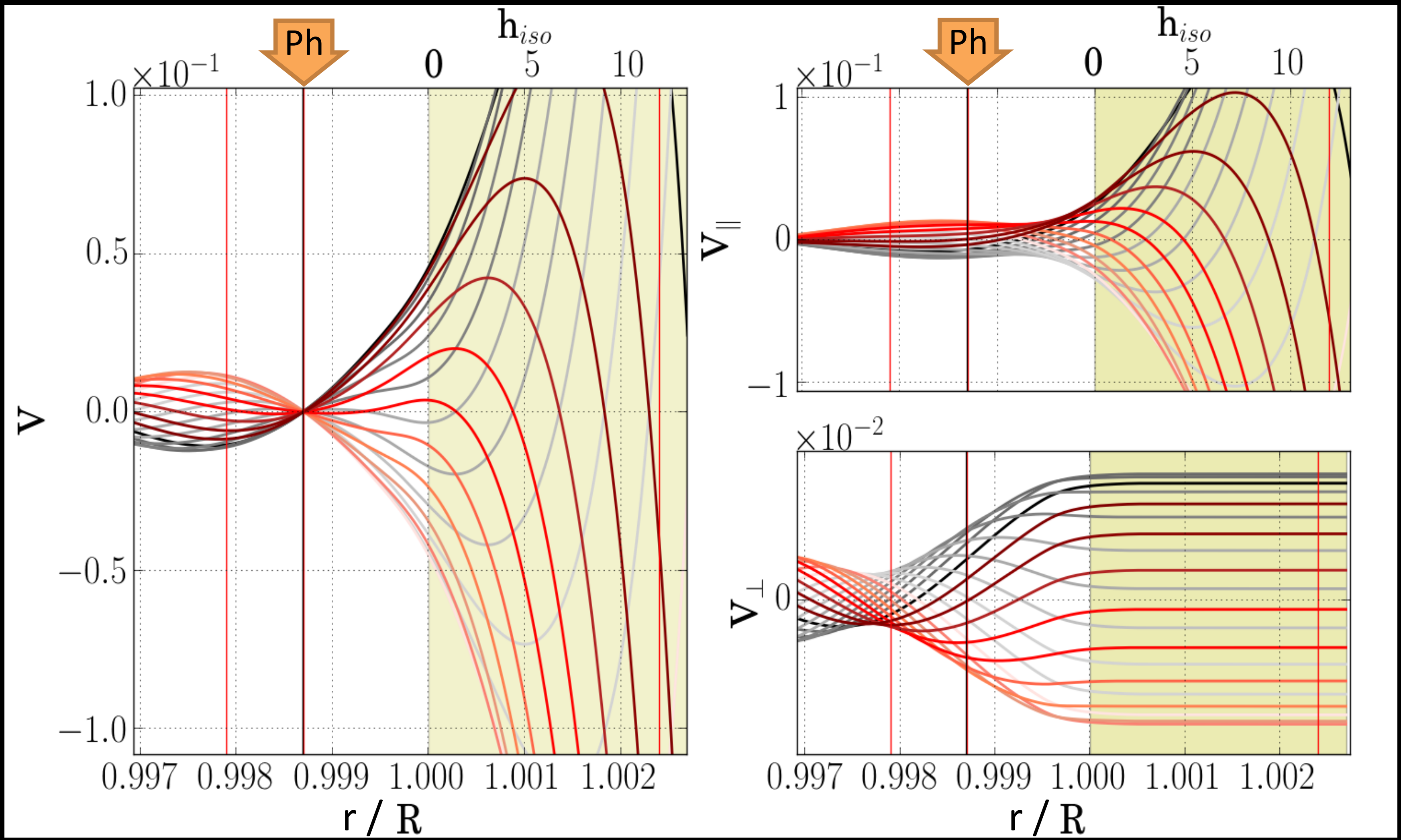
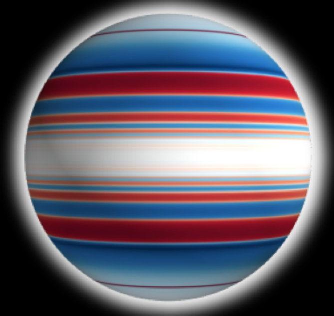
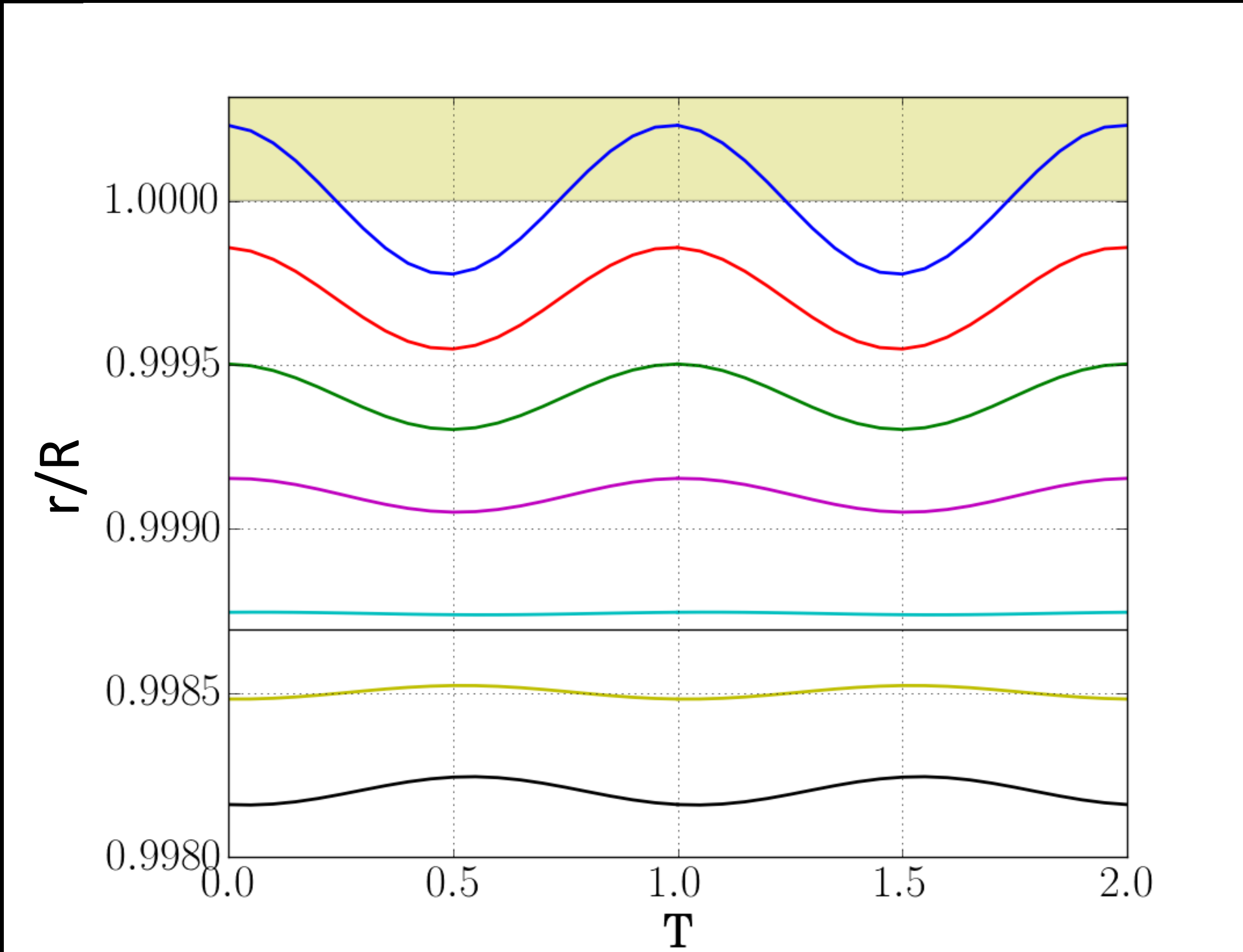




Integrated Radial Velocity

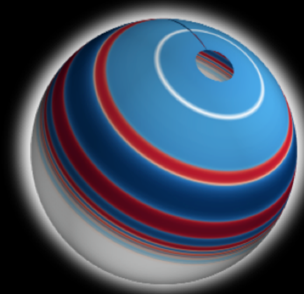
Frequency = 2.22mHz -- l = 2 -- equator-on

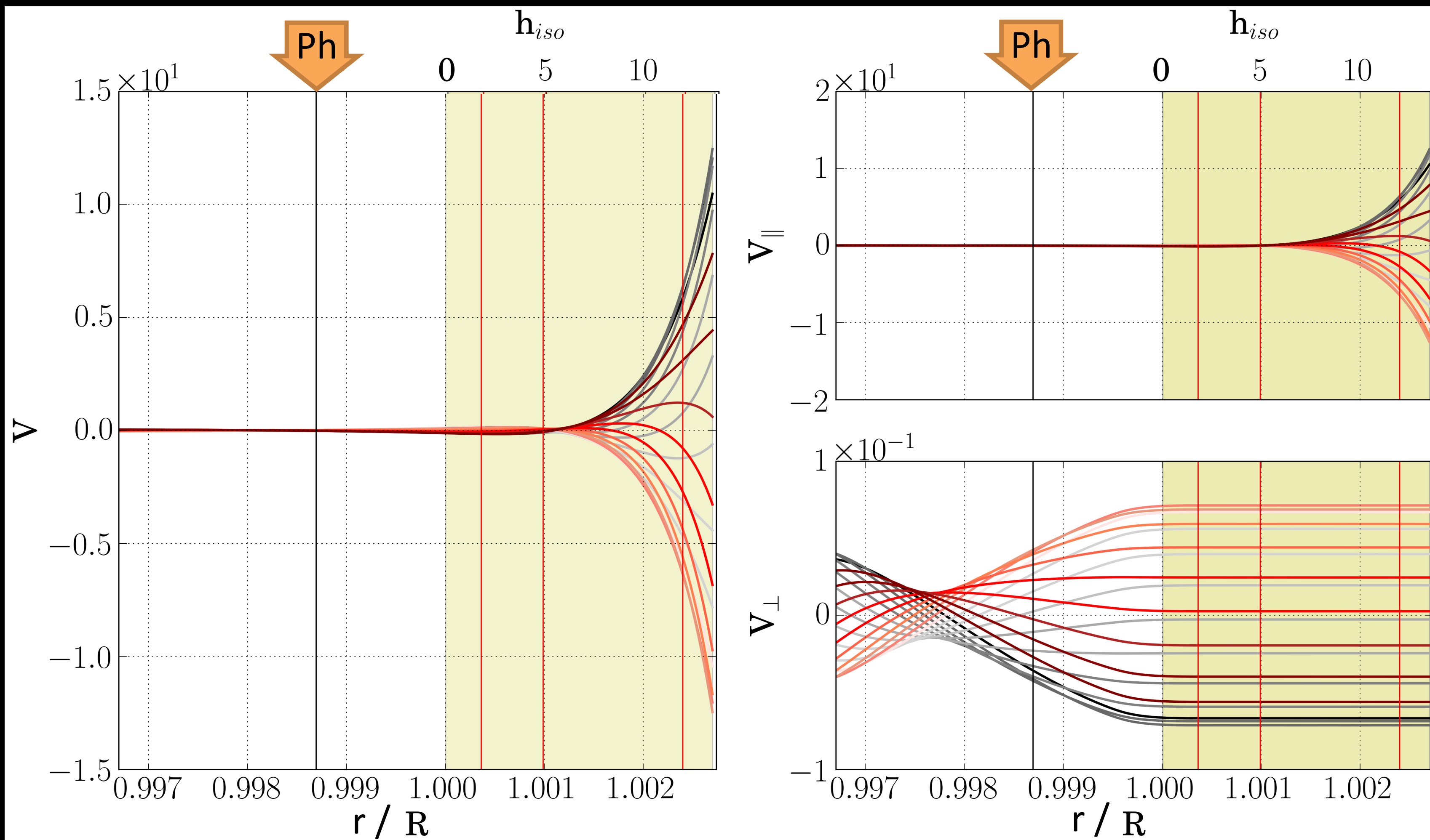




Integrated Radial Velocity

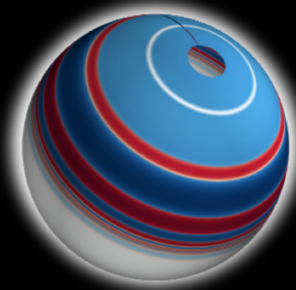
Frequency = 2.4mHz -- l = 4 -- pole-on

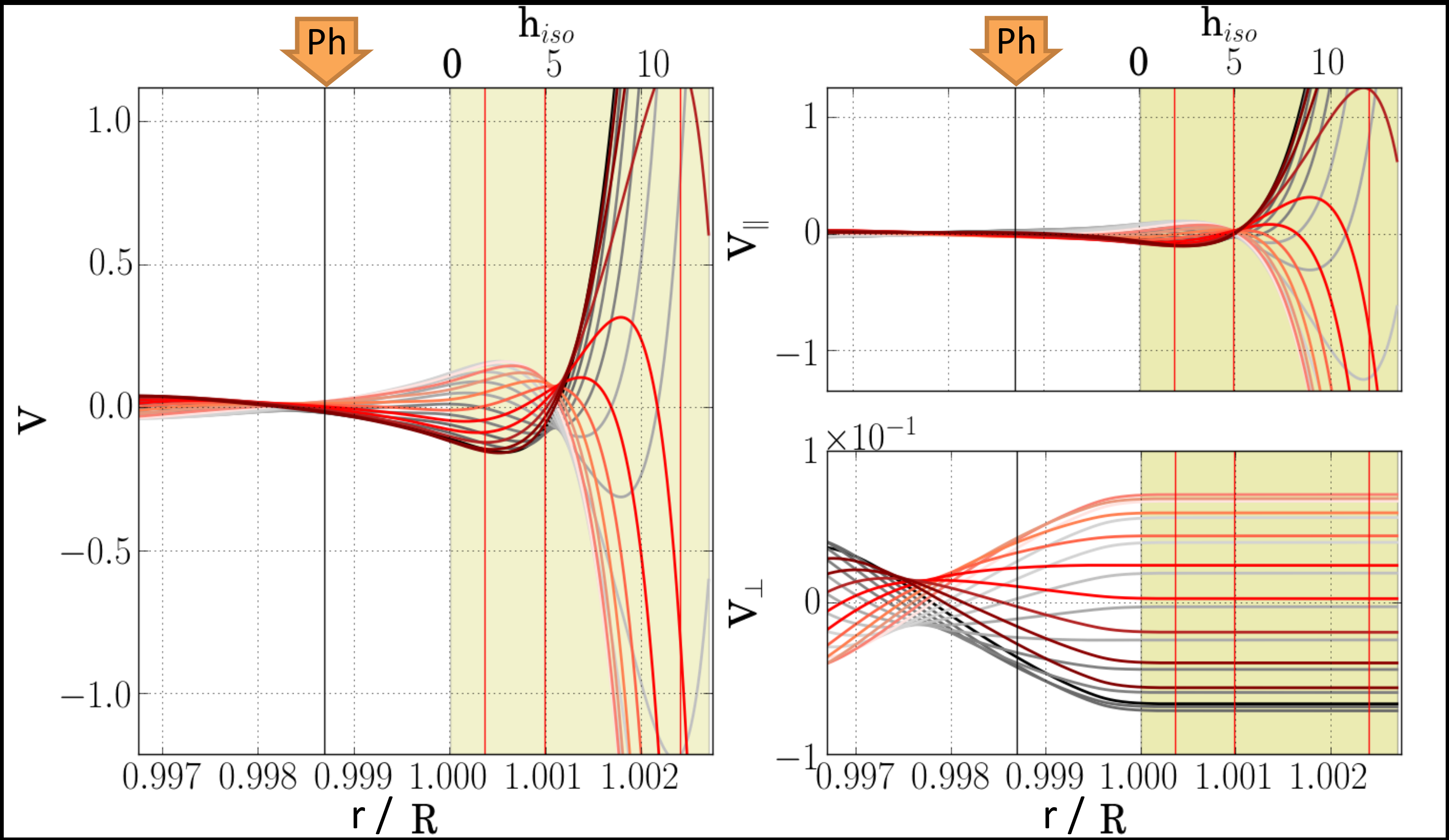




Integrated Radial Velocity

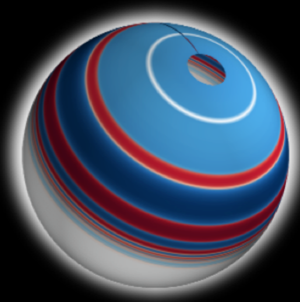
Frequency = 2.4mHz -- l = 4 -- pole-on

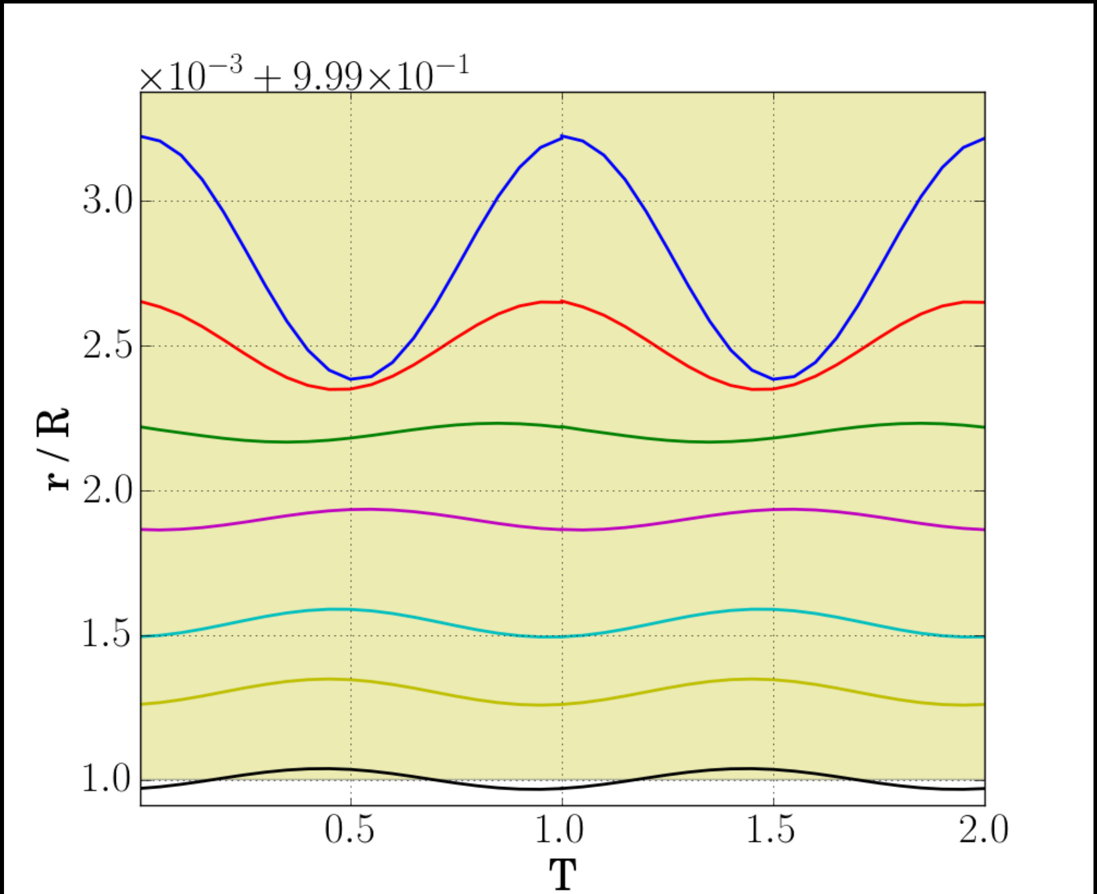




Integrated Radial Velocity

Frequency = 2.4mHz -- l = 4 -- pole-on





Summary:

- We built a tool to calculate the Integrated radial velocities
- We have confirmed that the observer sees a very complex picture due to the fact that there is an integration over the disc
- We plan to use the tool to forward model the radial velocity observed in roAp stars

Thanks

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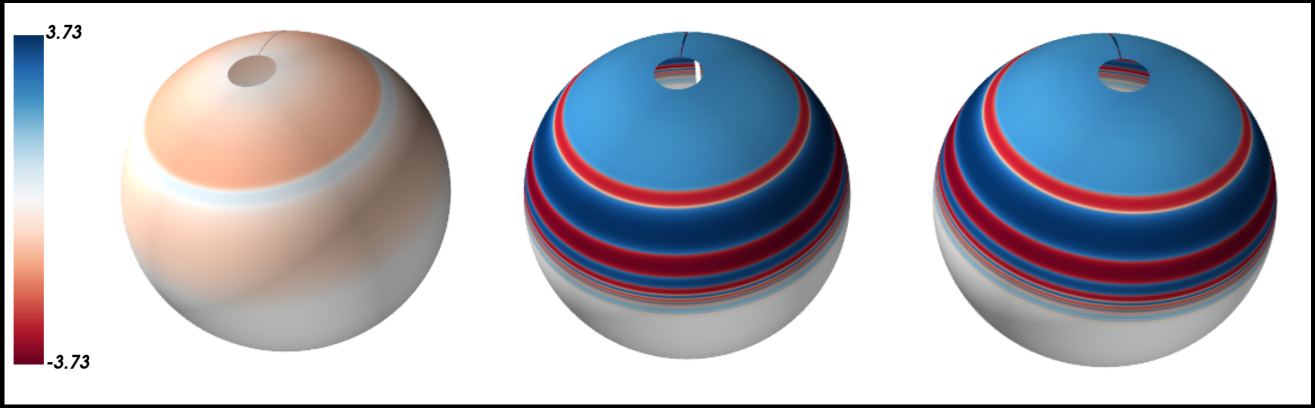

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