



LIGO high-frequency response to length- and GW-induced optical path length variations

Rick Savage

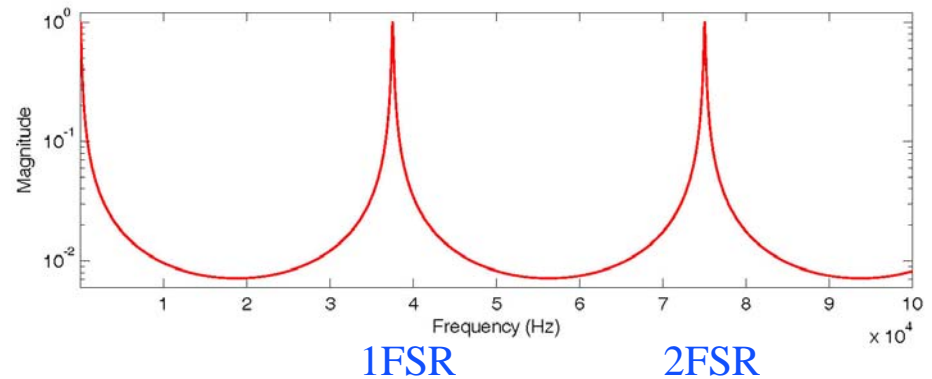
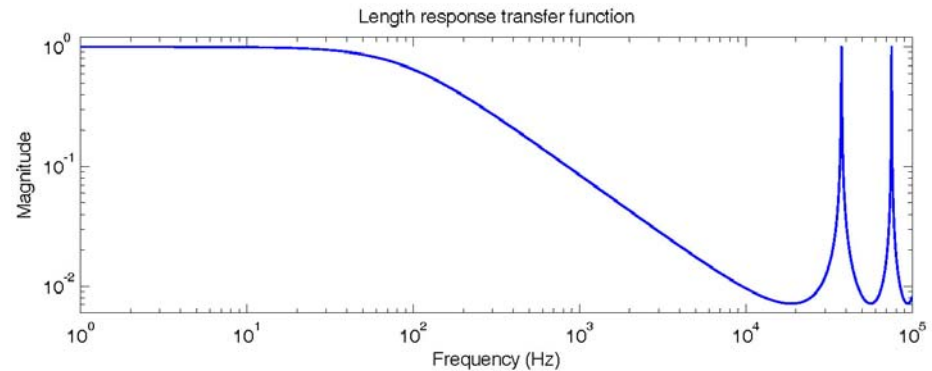
Malik Rakhmanov and Hunter Elliott

$$H_L(s) = \frac{1 - r_a r_b}{1 - r_a r_b e^{-2sT}}$$

r_a, r_b : mirror reflectivities

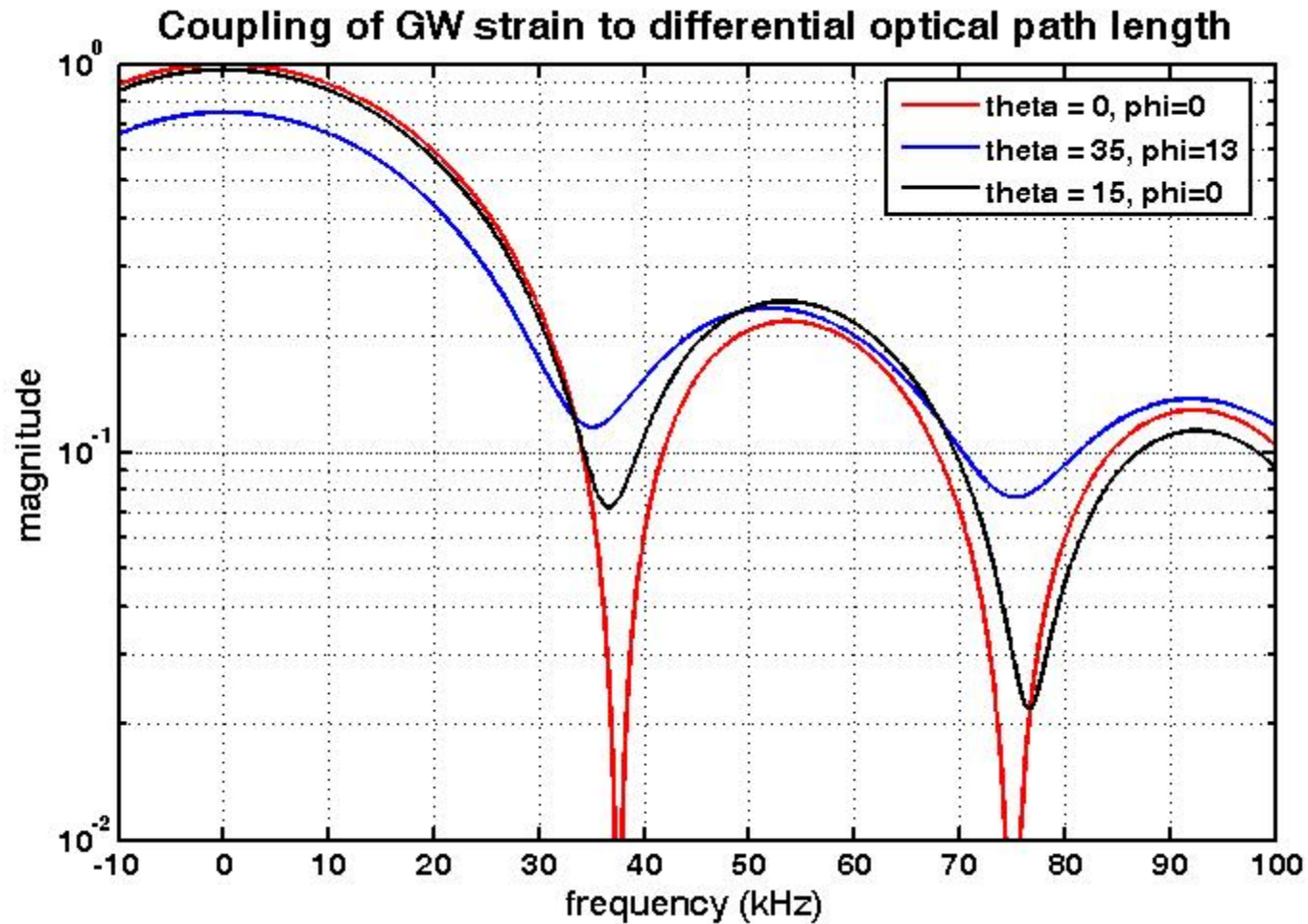
T : cavity transit time

Square root of the familiar Airy profile

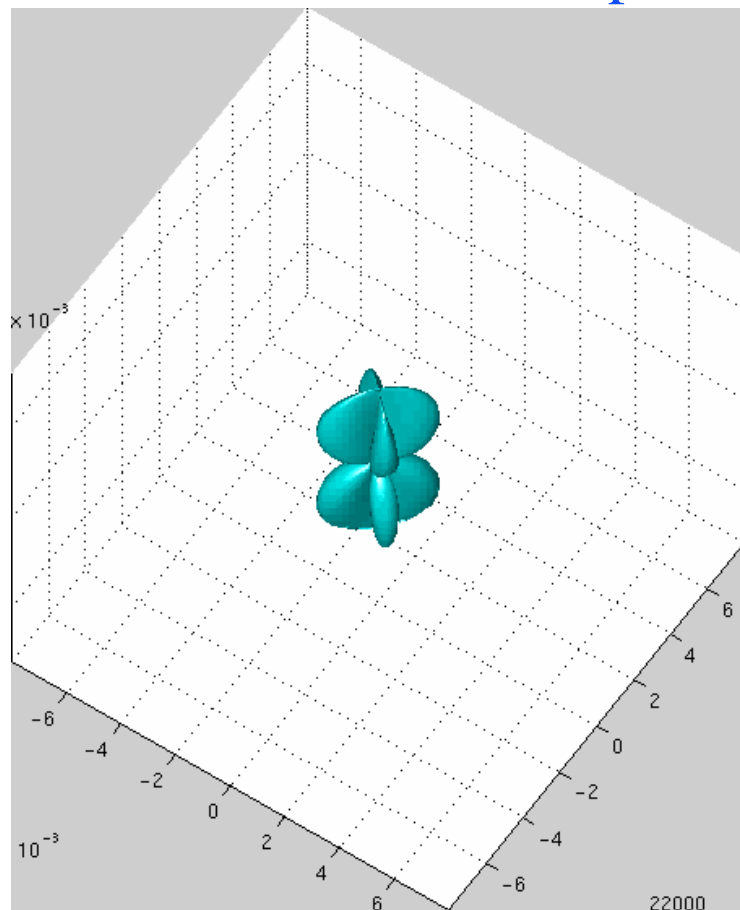




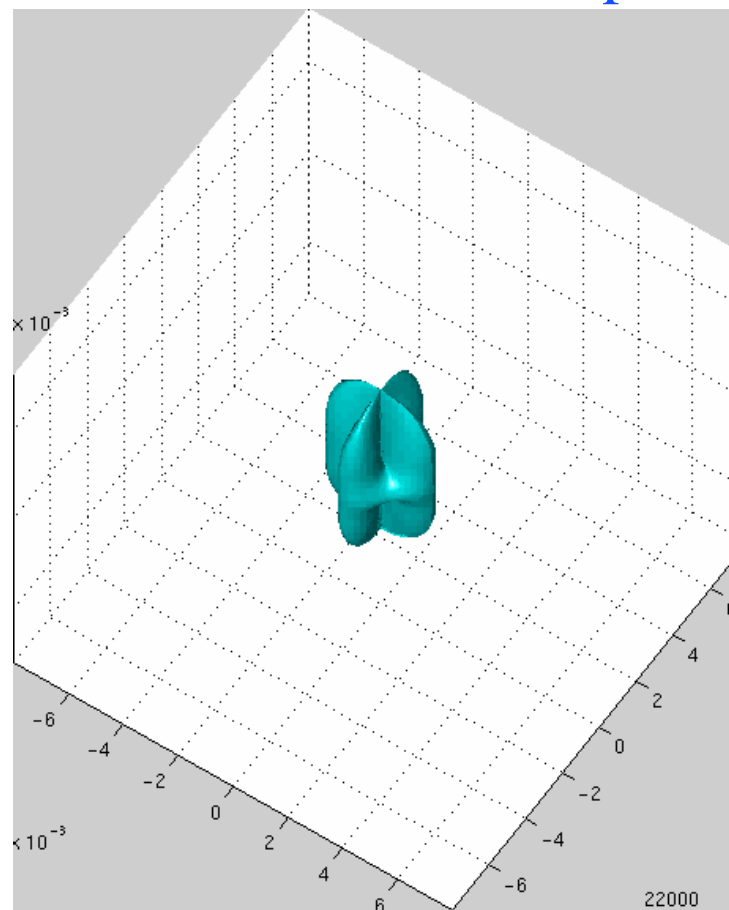
Coupling of GW to differential OPL change



Cross pol.



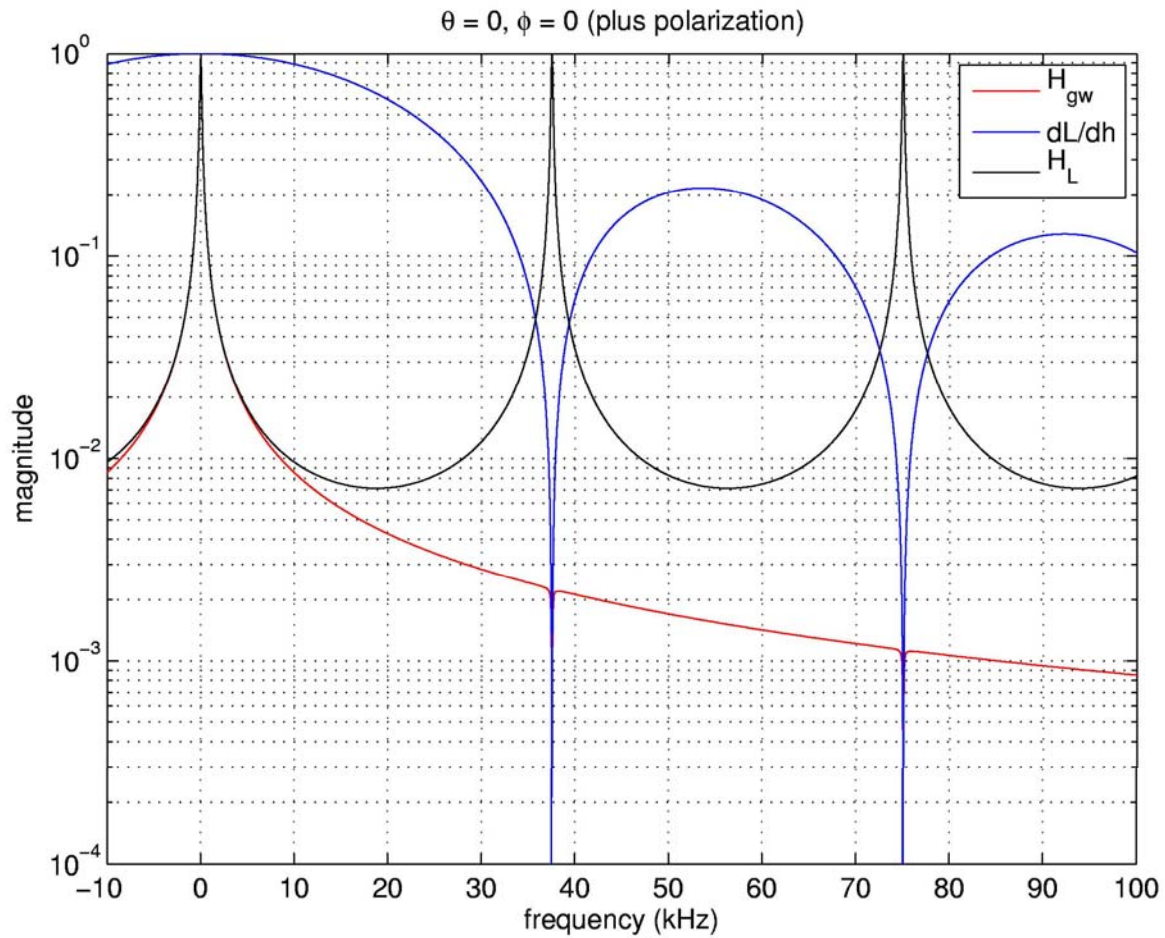
Plus pol.



Animations by Hunter Elliott

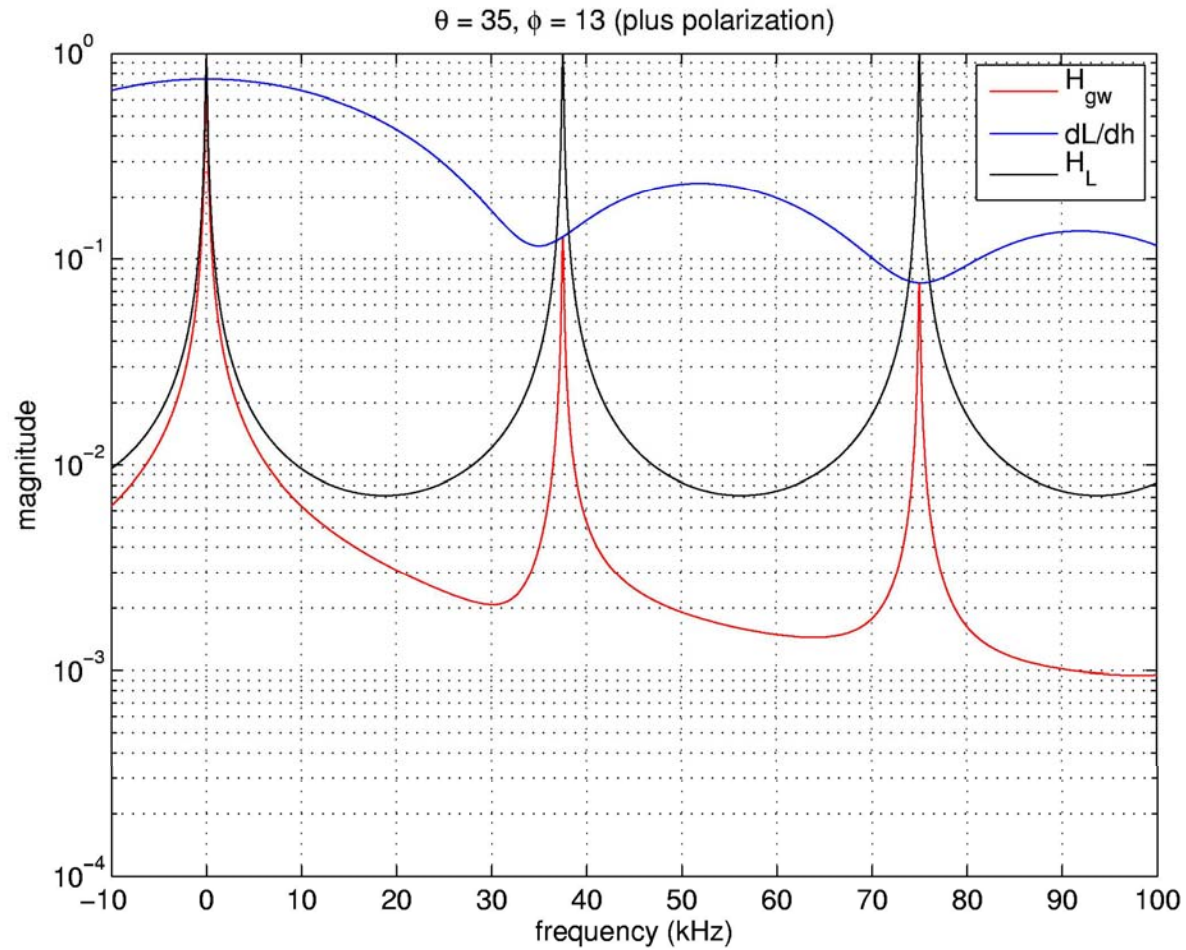


Interferometer response to GW



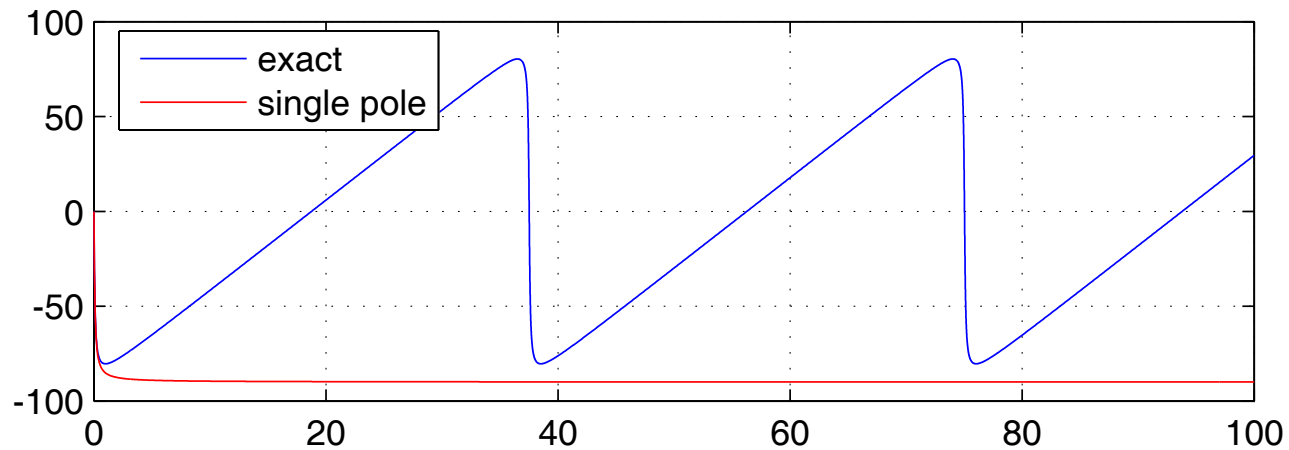
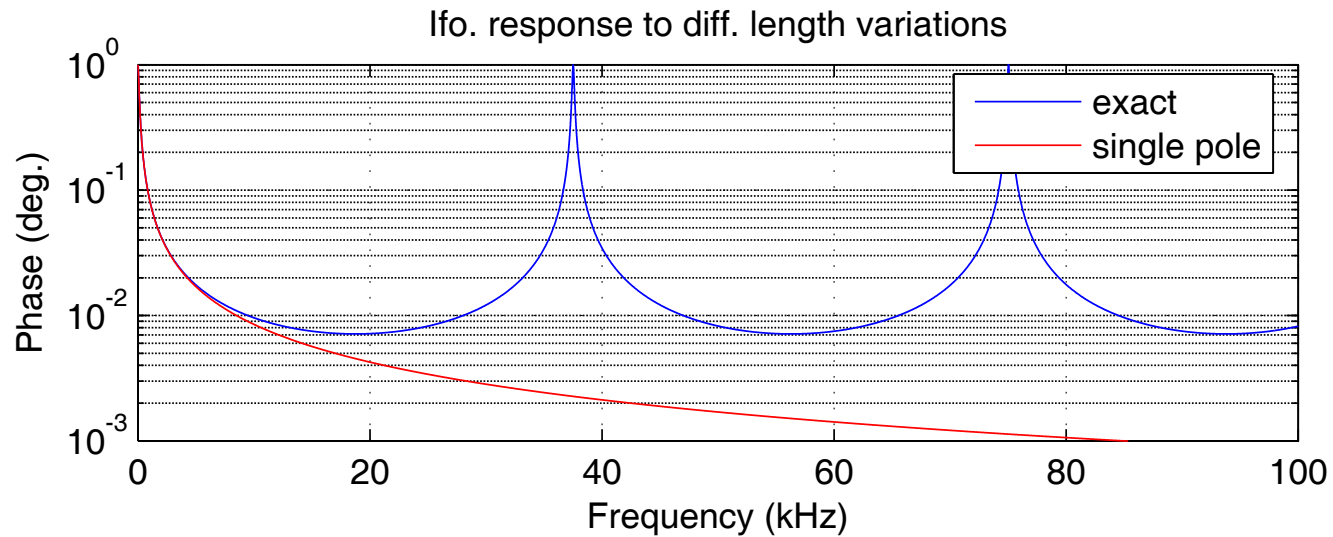


Same plot for different sky location



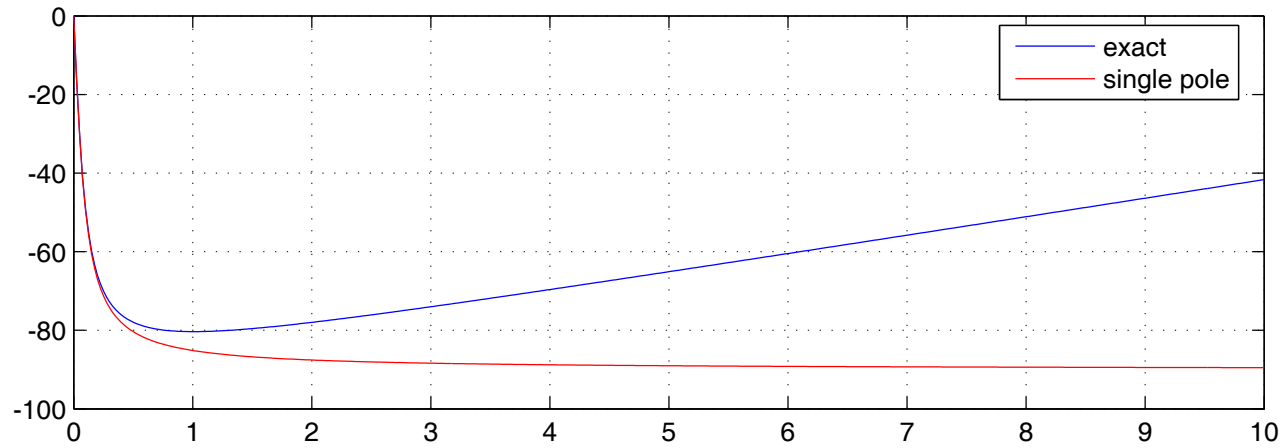
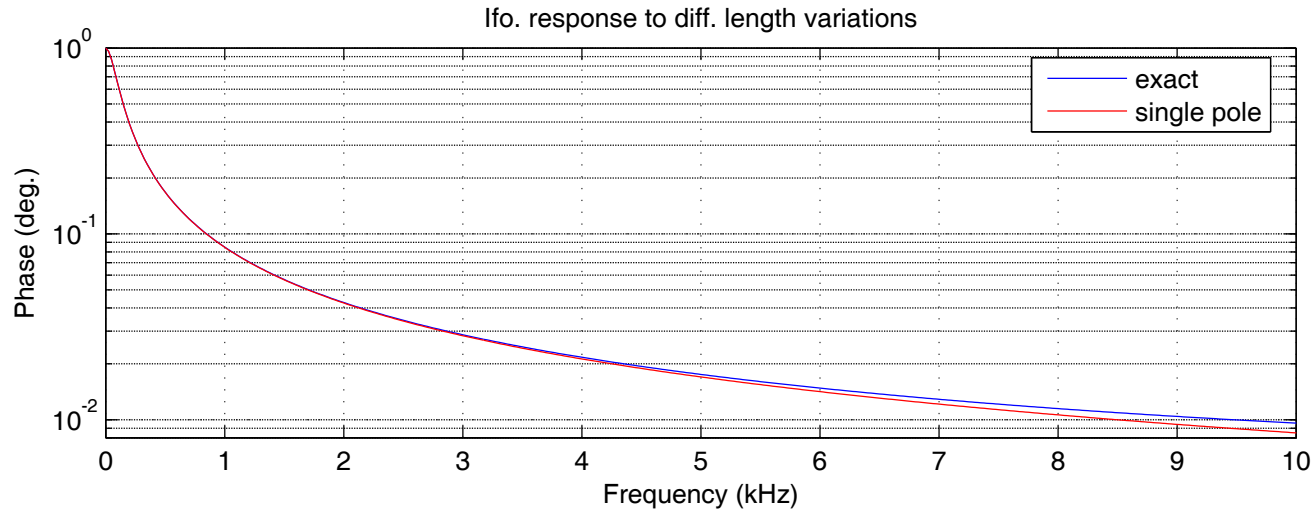


Approximations – single pole for length response



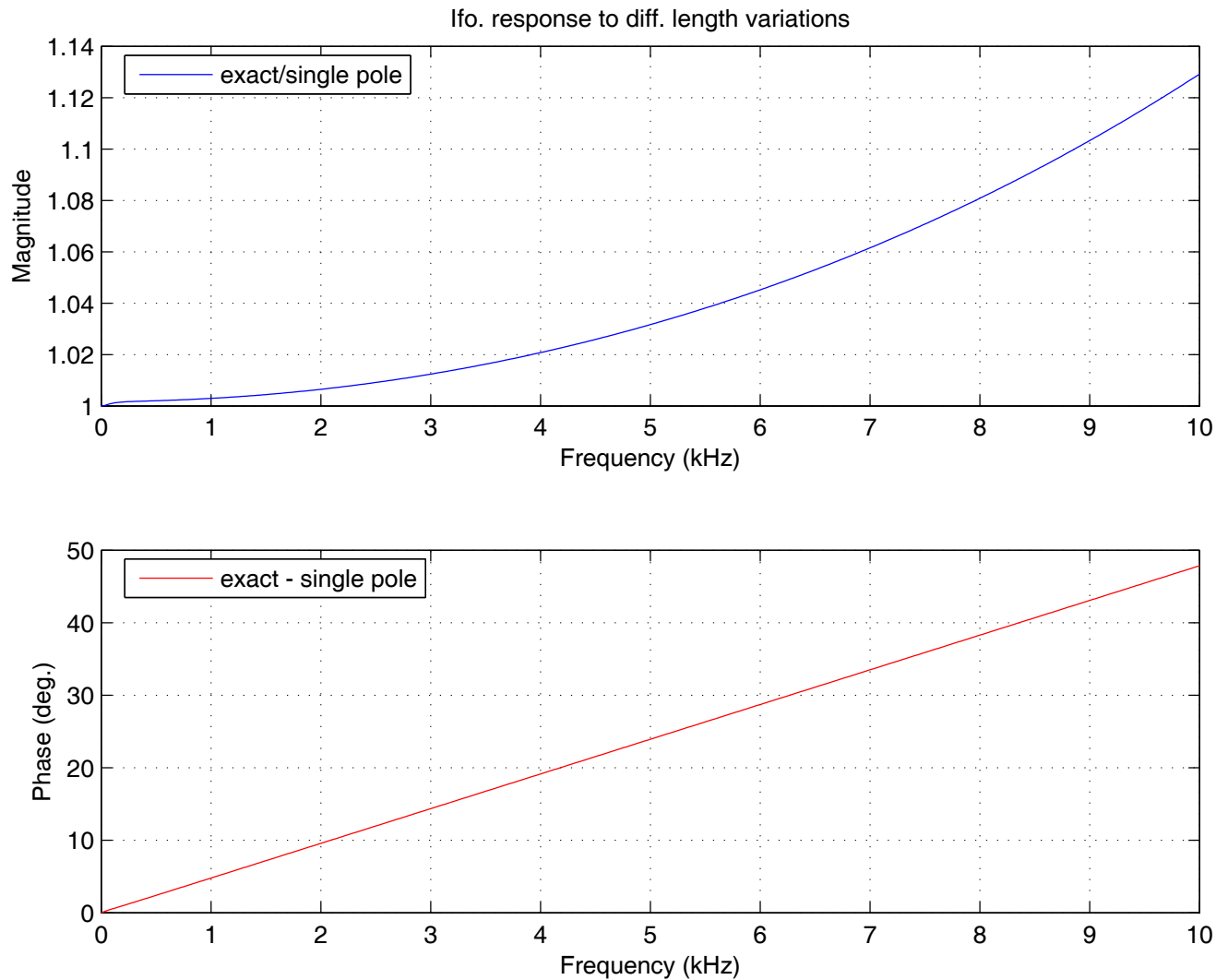


Detail DC to 10 kHz



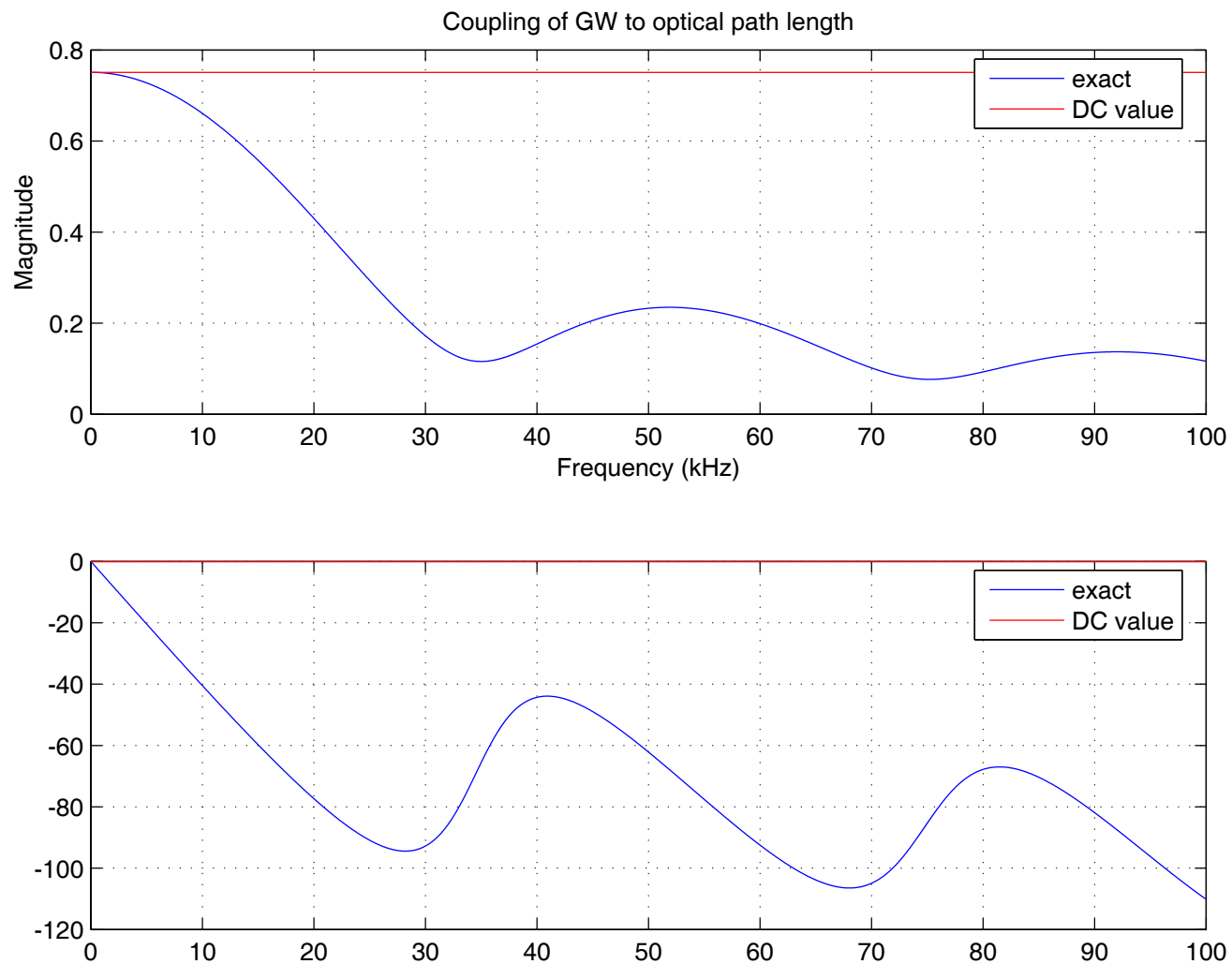


Length response discrepancy

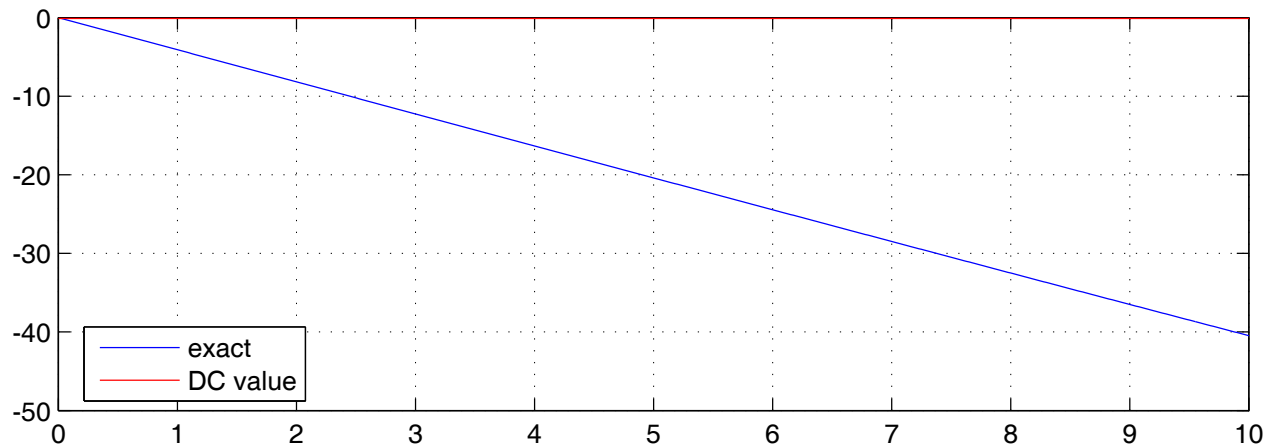
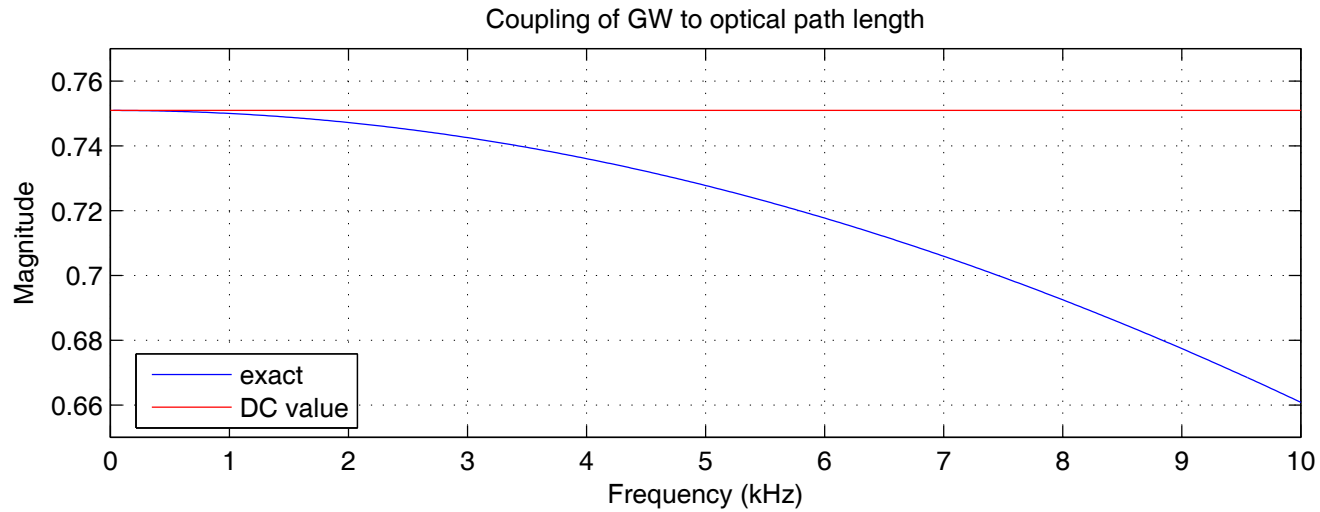




GW coupling to diff. OPL ($\theta = 35$, $\phi = 13$)

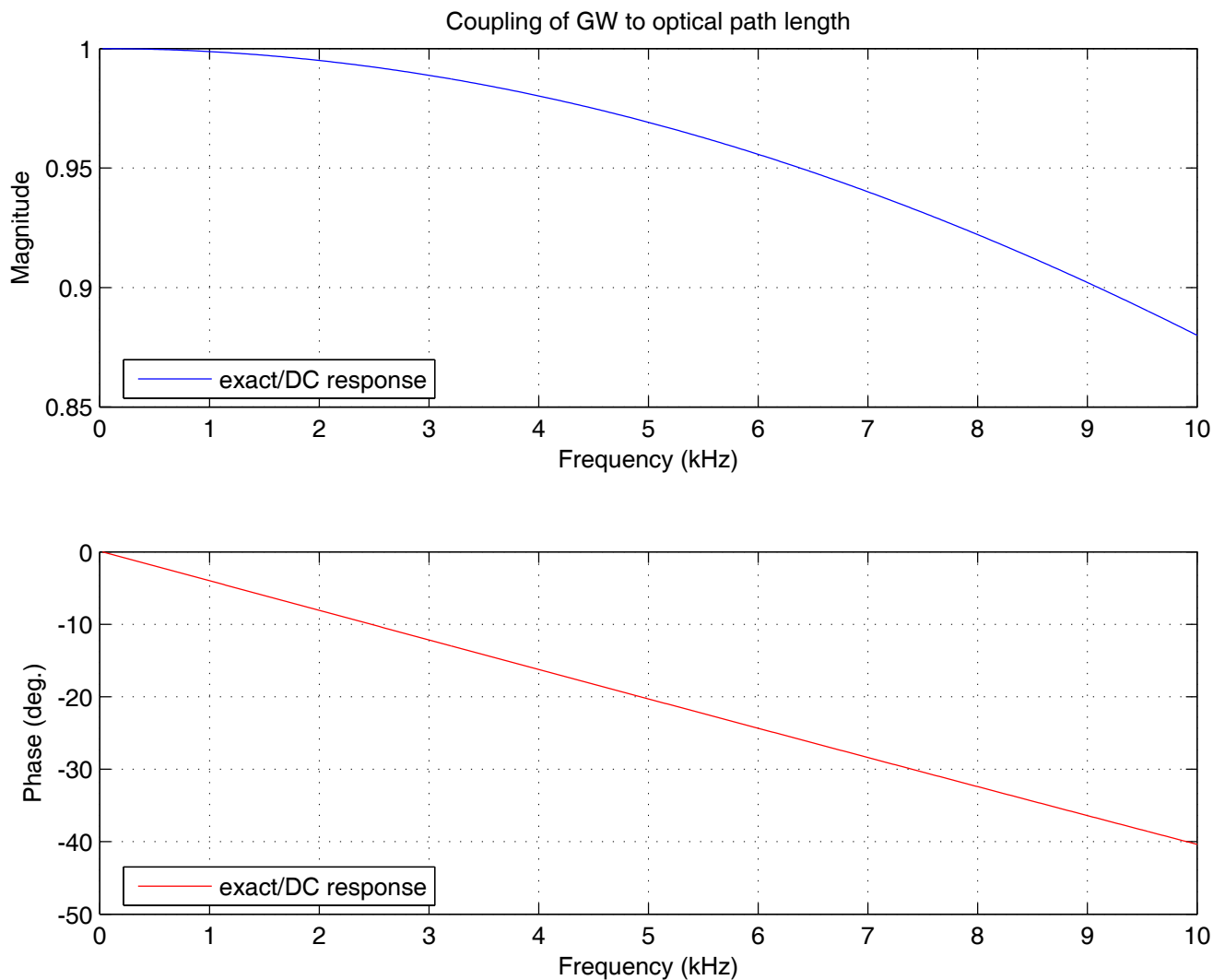


Detail to 10 kHz



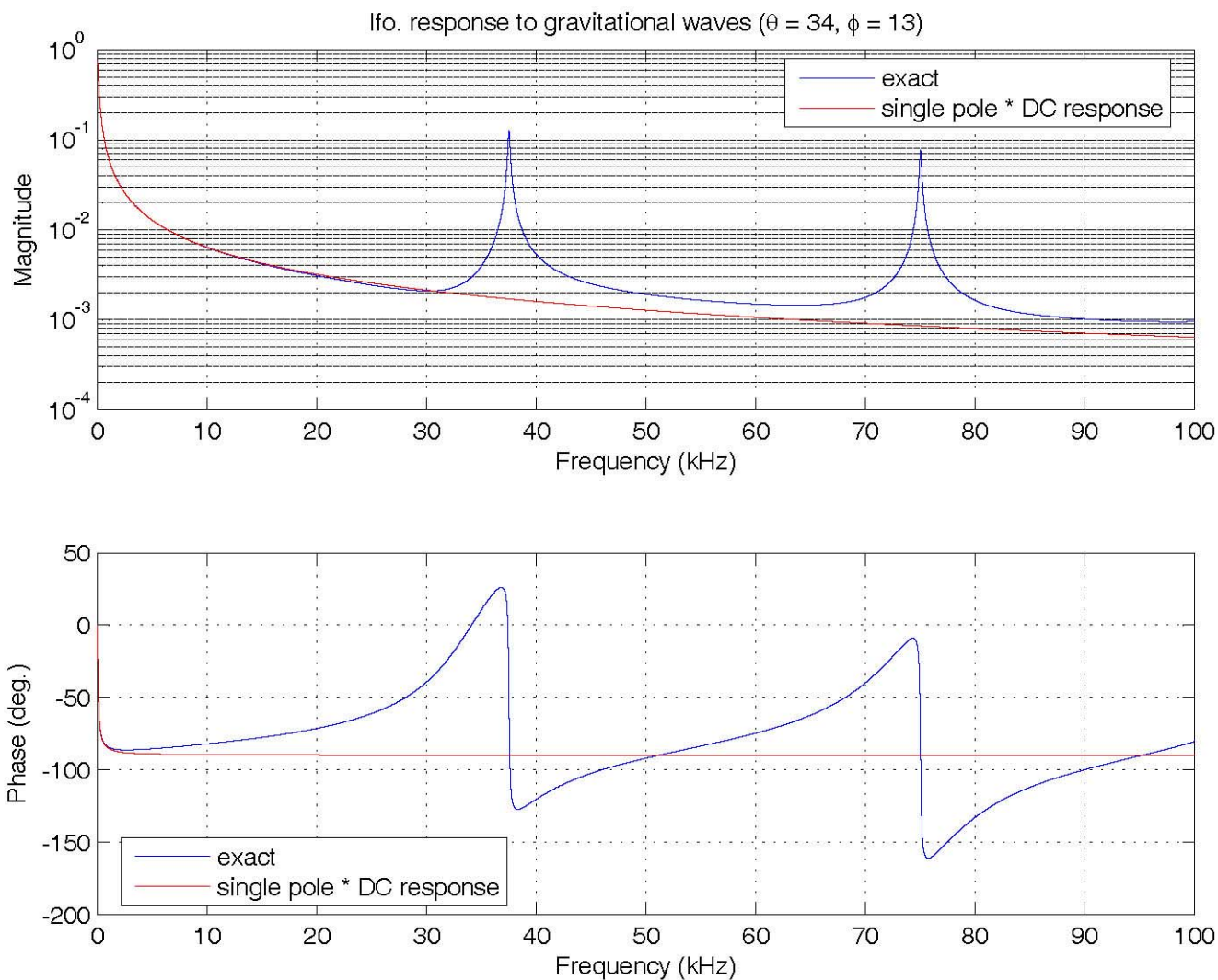


Ratio of exact coupling to DC value



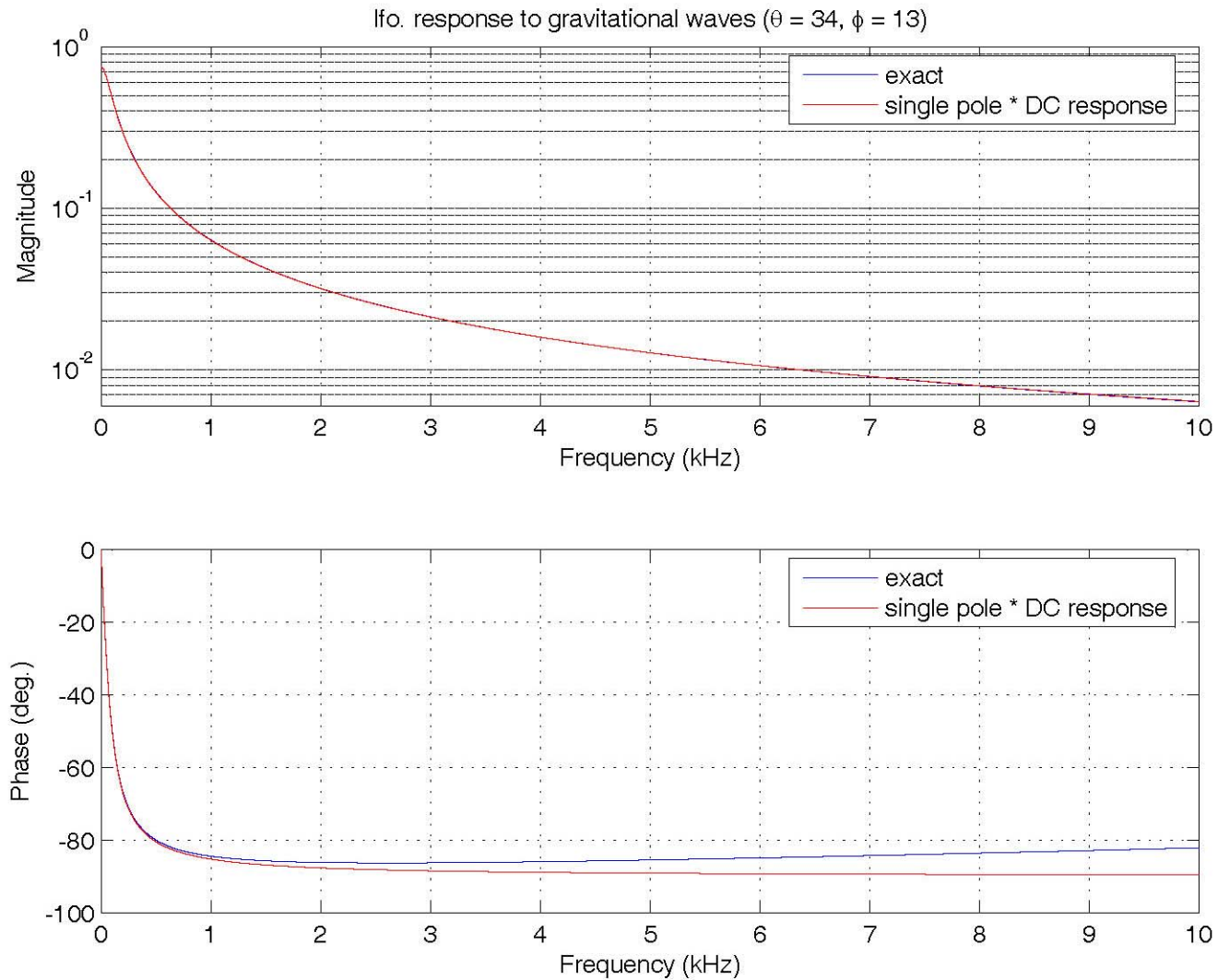


Interferometer response to GWs



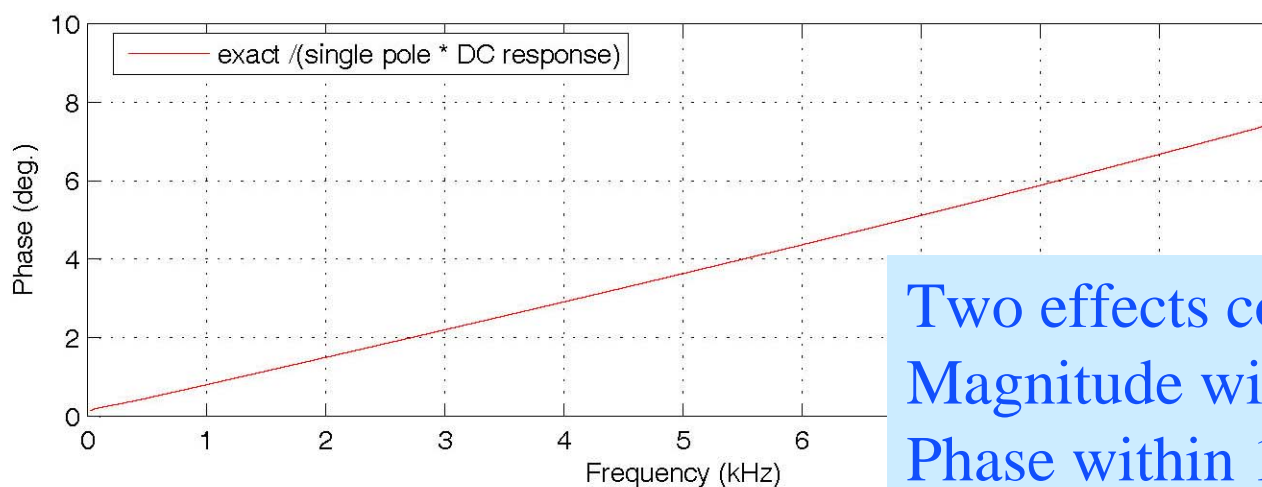
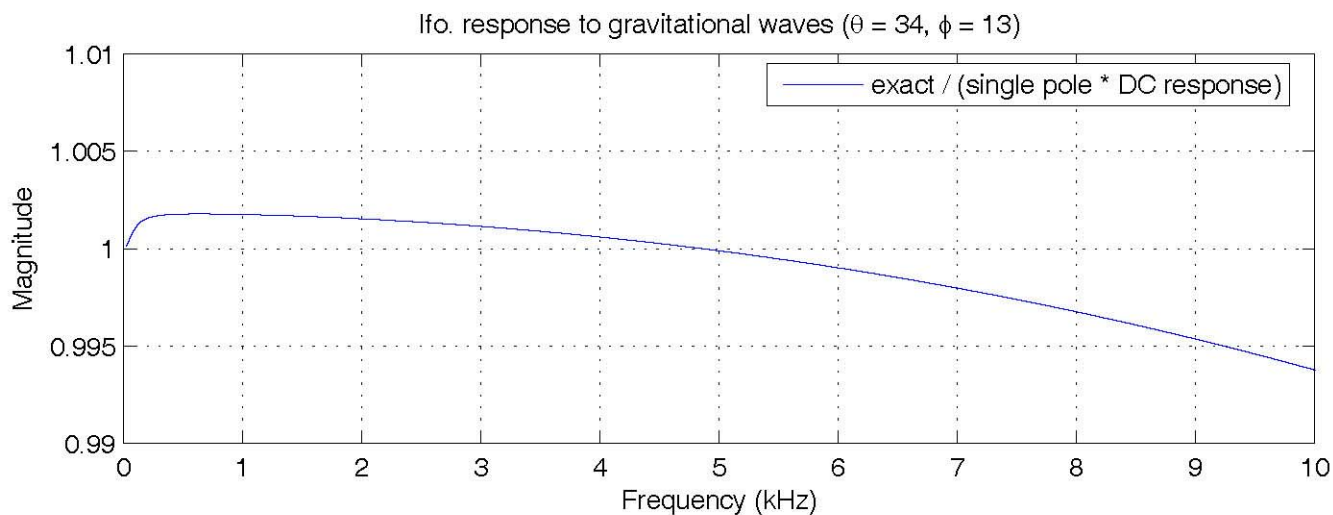


Detail to 10 kHz





Ratio of exact response to approximation



Two effects compensate:
Magnitude within 1%
Phase within 10 deg.