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Glassy Metals

A Possible Solution For Reducing The Thermal Noise In Mirror Suspensions

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LIGO-G020430-00-R

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Why Glassy Metals?

- Problems
- Mirror Suspension Thermal Noise Caused By Dissipation of Suspension Oscillation Energy
- Solutions

1. Use High Quality Factor Materials
2. Optimize Suspension Geometry

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Fused Silica Vs. Glassy Metals

- Fused Silica

1. Higher Internal Q Factor

1. Lower Useful Yield Point
2. Limited Geometries

- Glassy Metals

1. Higher Useful Yield Point
2. Resistant to Corrosion
3. Better Geometries

1. Lower Internal Q Factor

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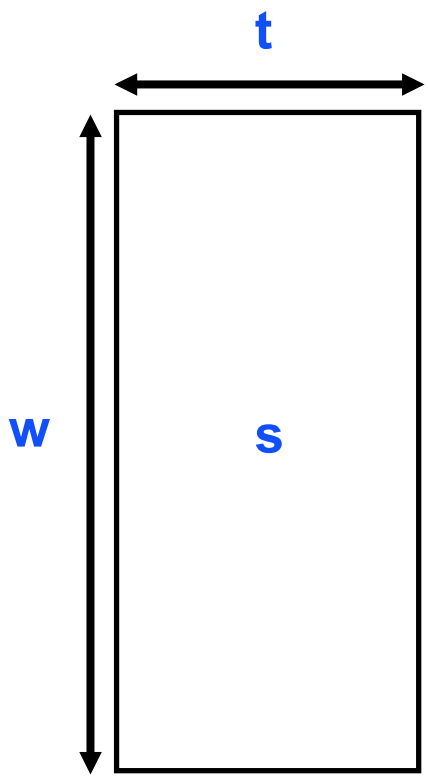
Effect of Geometry on Q Factor

- Q Factor
- $Q_p = Q_o\,(1+K_G/K_{SP}) \approx Q_o\,(K_G/K_{SP})$

- Restoring Force of Spring
- $K_{SP} = EI$

- Inertia
- $I = wt^3/2 = st^2/2$



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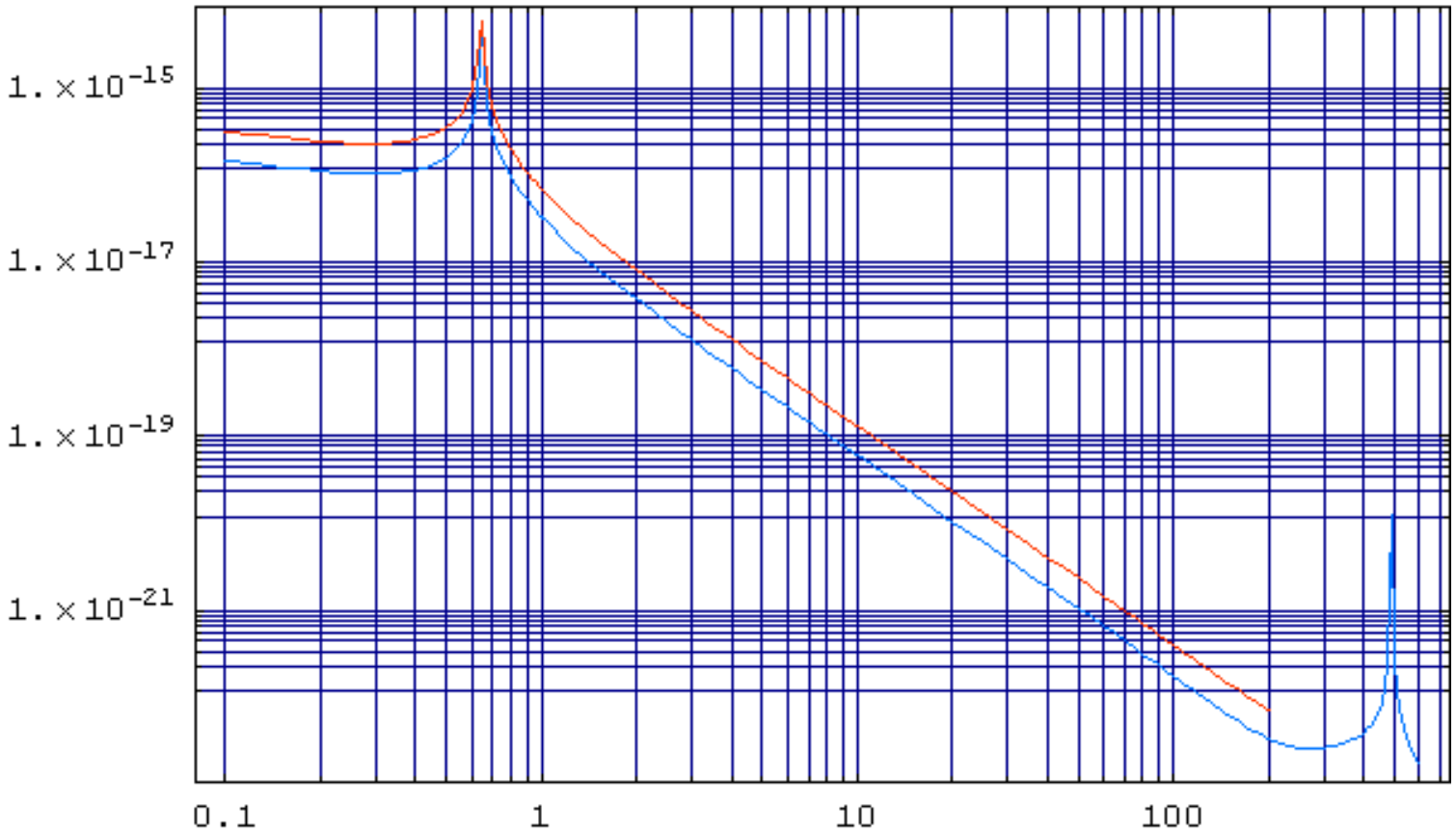
MoRuB - Estimates

- Density, 10.3 g/cc
- Heat Conductivity, 10 W/K-m
- Heat Capacitance, 30 J/K-mole
- Thermal Expansion Coefficient, 5.5×10^{-6} (K^{-1})
- Elastic Modulus, 250 GPa
- Poisson Modulus, 0.36 – 0.38
- Breaking Point, > 5 GPa

- These numbers should be accurate to ± ~20%.

MoRuB Performance (P. Willems)



Glassy Metal
Q = 10^4
10 x 3000 = 30,000μm
60 kg Mirror

Fused SiO2 Dumb Bell Shaped Fiber
Q = 8.4 x 10^8
357 um diameter, 100,000 um2
40 kg Mirror

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The Glassy Metals Team

• Maddalena Mantovani	Hardness & Elasticity / Undergraduate
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• Brian Emmerson	X-Ray Diffraction / Undergraduate
• Michael Hall	Thermal Properties / Undergraduate
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• Rosalia Stellacci	Creep Analysis / Undergraduate
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