Numerical Analysis of Wave Propagation in a Tapped Hole used as a Slow Wave Structure

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TECHNISCHE UNIVERSITÄT DARMSTADT

DESY-TEMF-CANDLE
Summer Meeting on Video
21st September 2021

Overview

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- Motivation
- Numerical Modeling
  - Dispersion Diagram
    - Ordering with respect to Frequency or Modes
- Numerical Results
  - Dispersion Diagram for M1.0 to M2.0 in Steps of 0.2
  - Postprocessing
    - Phase Velocity
    - Group Velocity
  - Comparison to Measurements
- Summary and Outlook

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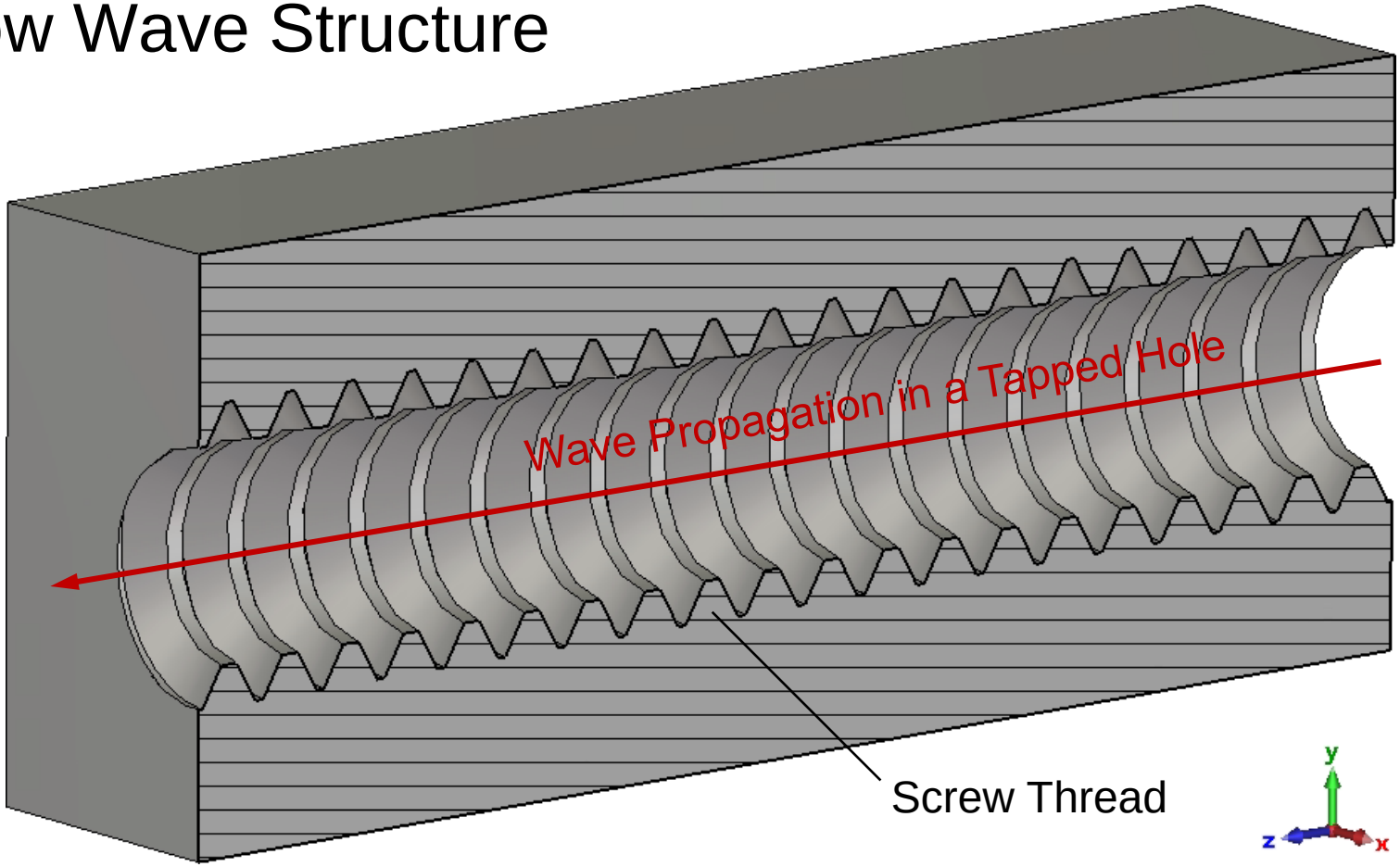
- Slow Wave Structure



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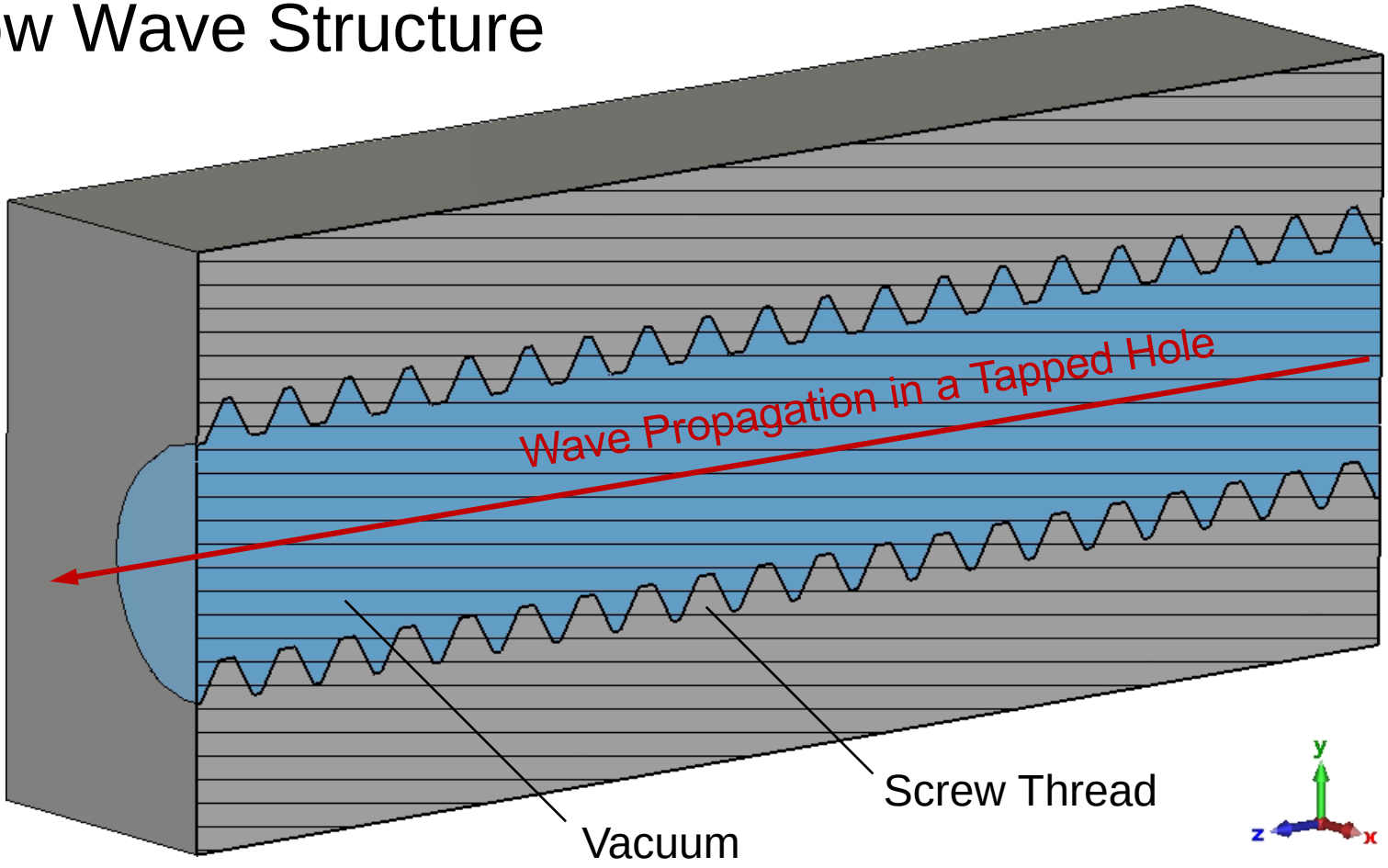

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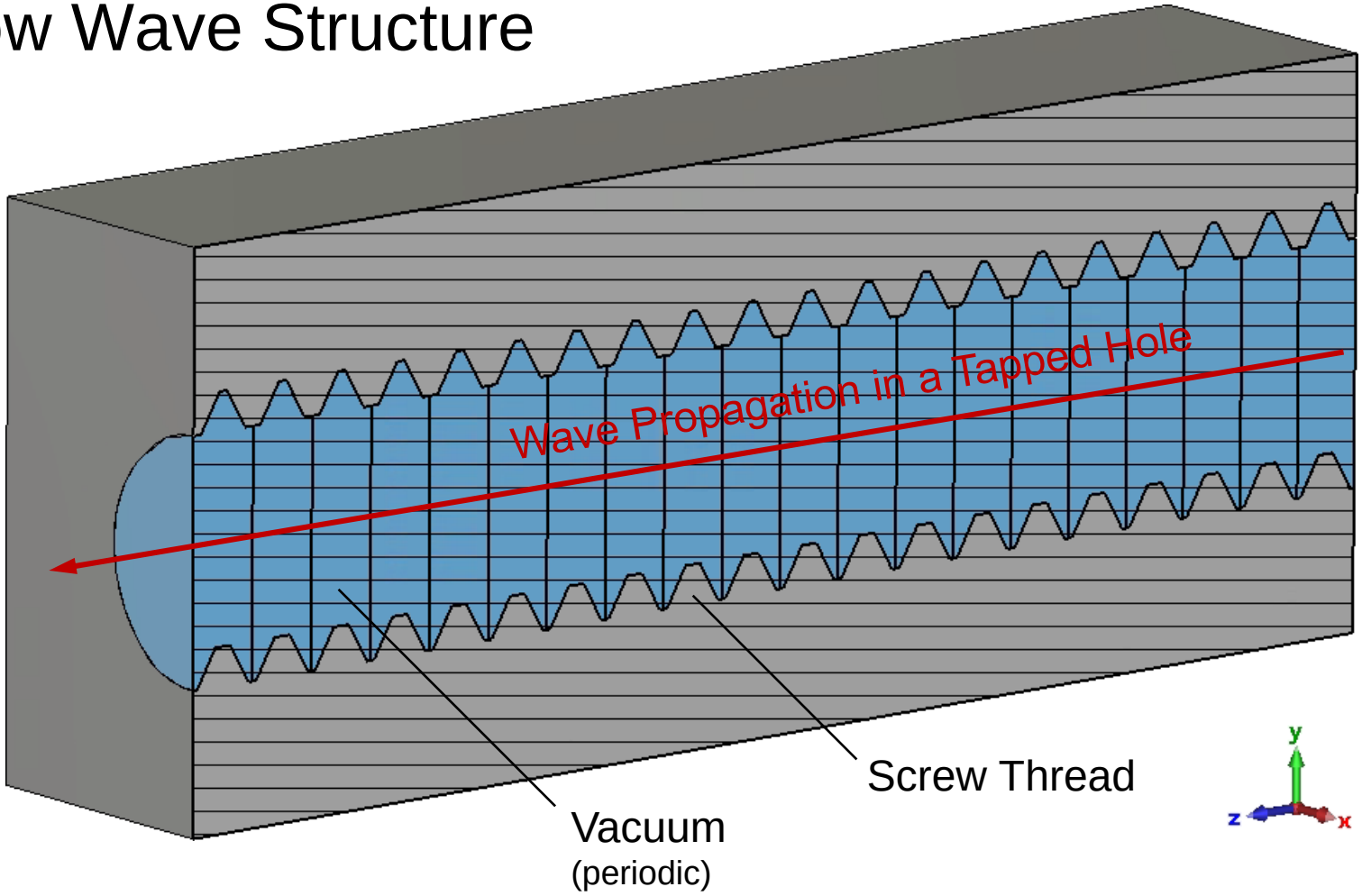

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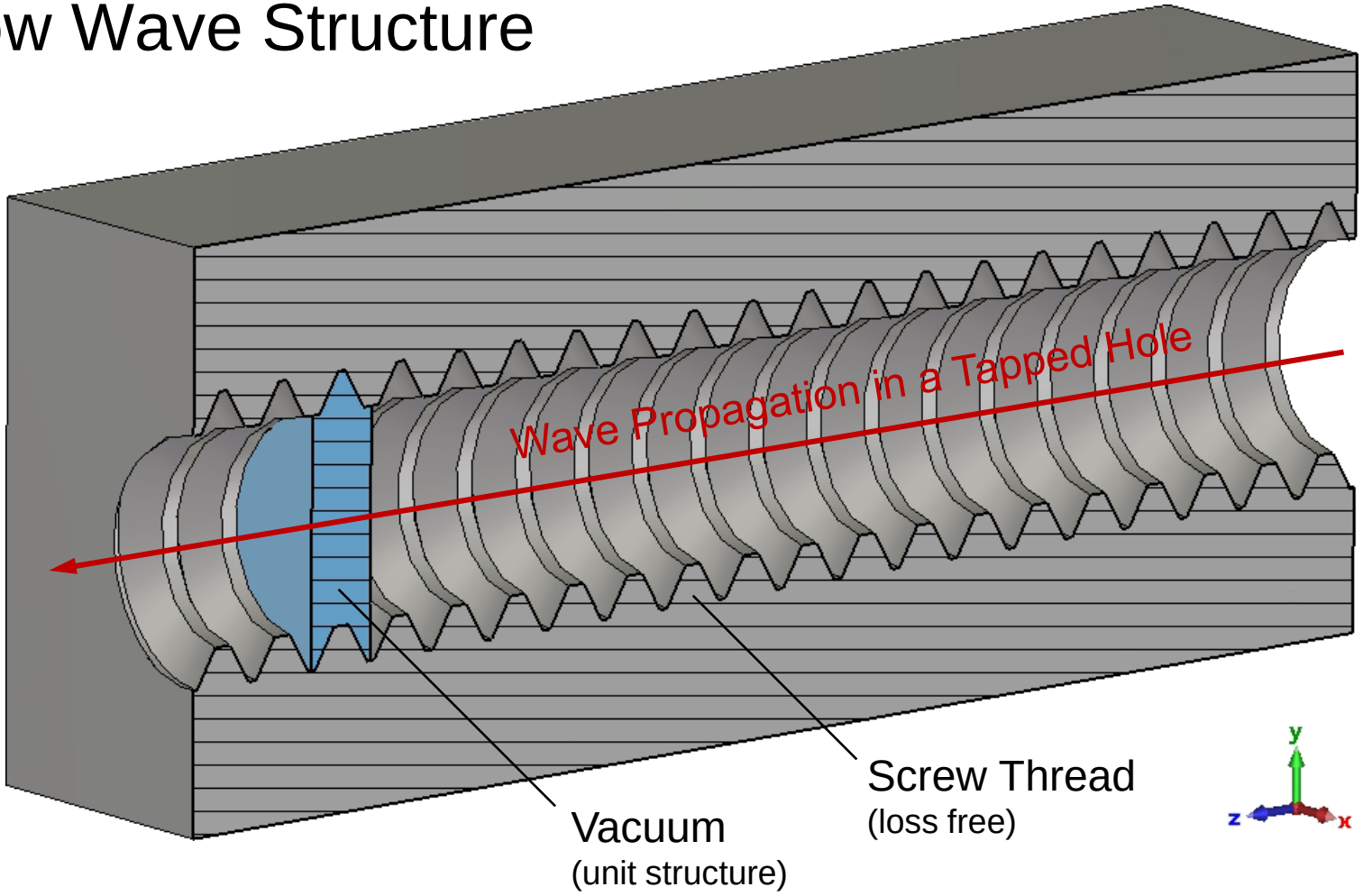

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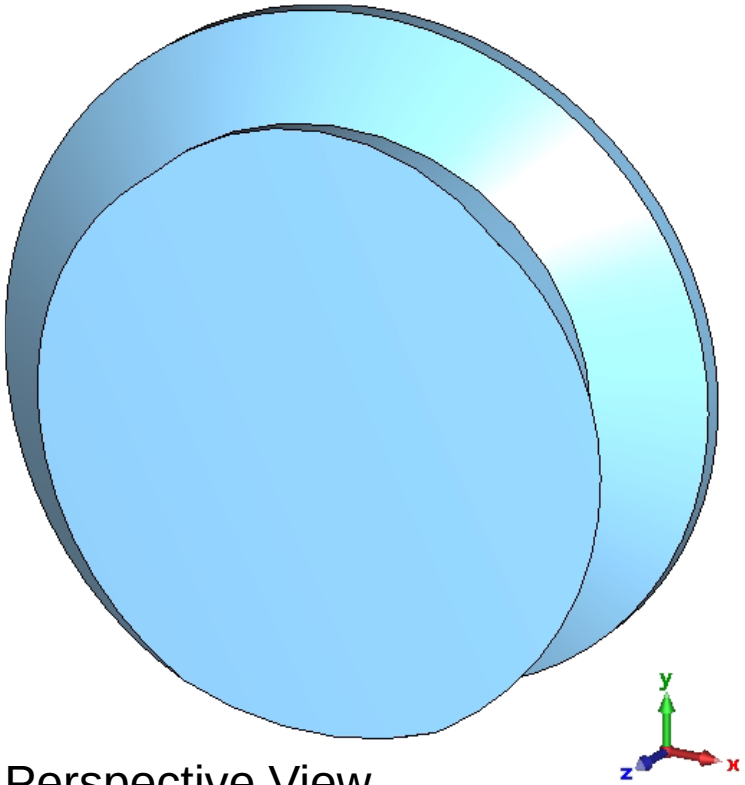
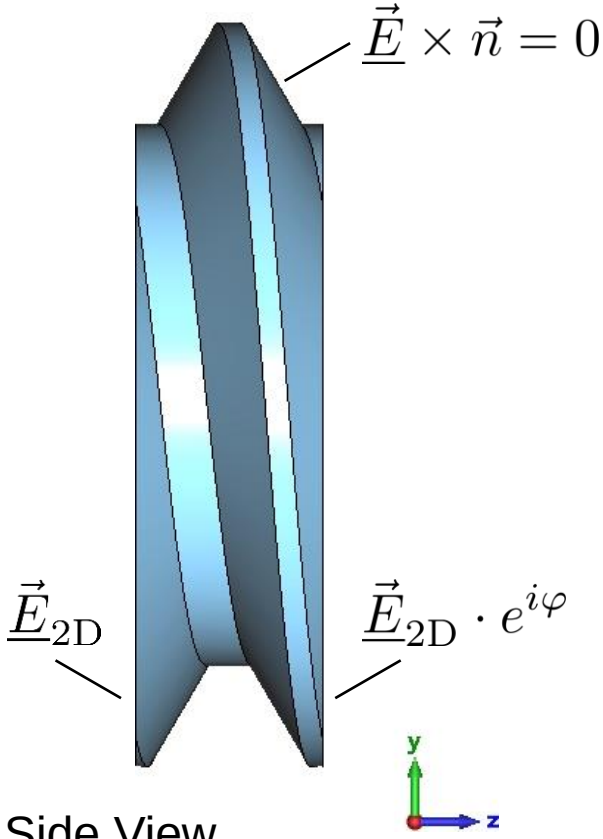
Numerical Modeling

- Slow Wave Unit Structure

$$\mathrm{curl}\frac{1}{\mu}\mathrm{curl}\underline{\vec{E}} = \omega^2\varepsilon\underline{\vec{E}}$$



Perspective View



Side View

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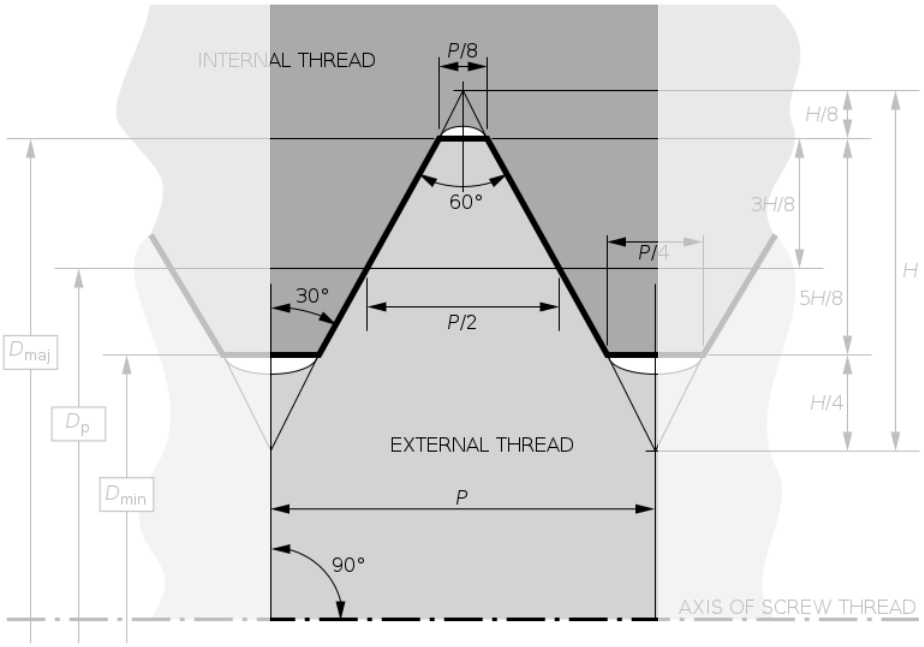
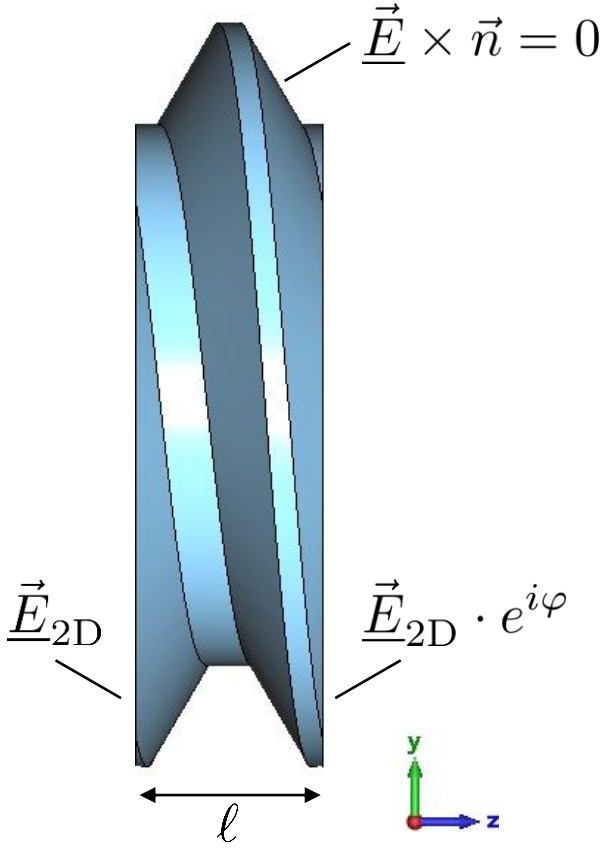
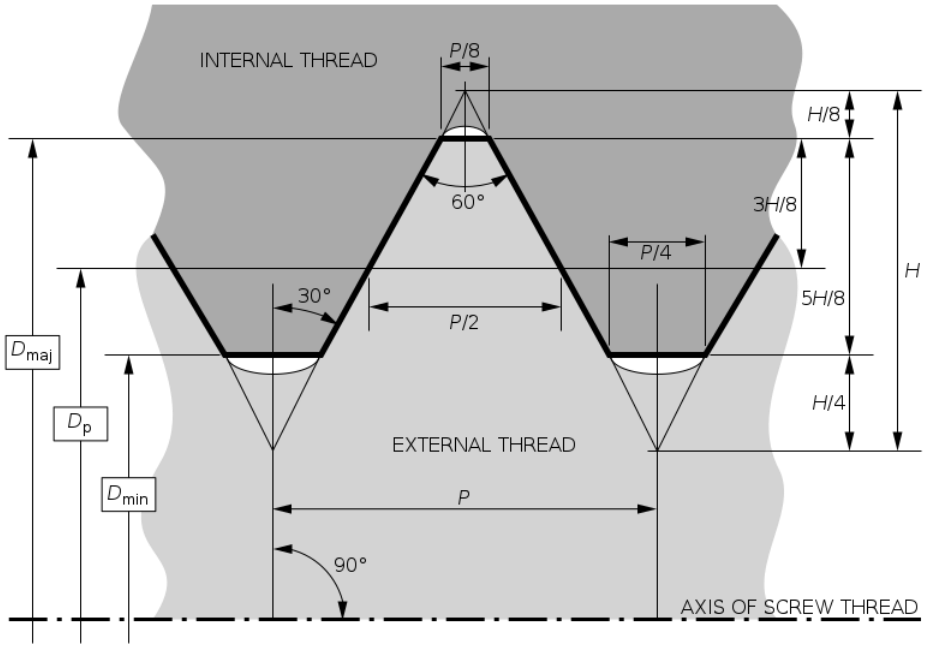


https://en.wikipedia.org/wiki/ISO_metric_screw_thread



Numerical Modeling

- Slow Wave Unit Structure (ISO metric screw thread)



	D_{maj}	D_{min}	p
M1.0	1.0	0.729	0.25
M1.2	1.2	0.929	0.25
M1.4	1.4	1.075	0.30
M1.6	1.6	1.221	0.35
M1.8	1.8	1.421	0.35
M2.0	2.0	1.567	0.40

unit of measure: mm

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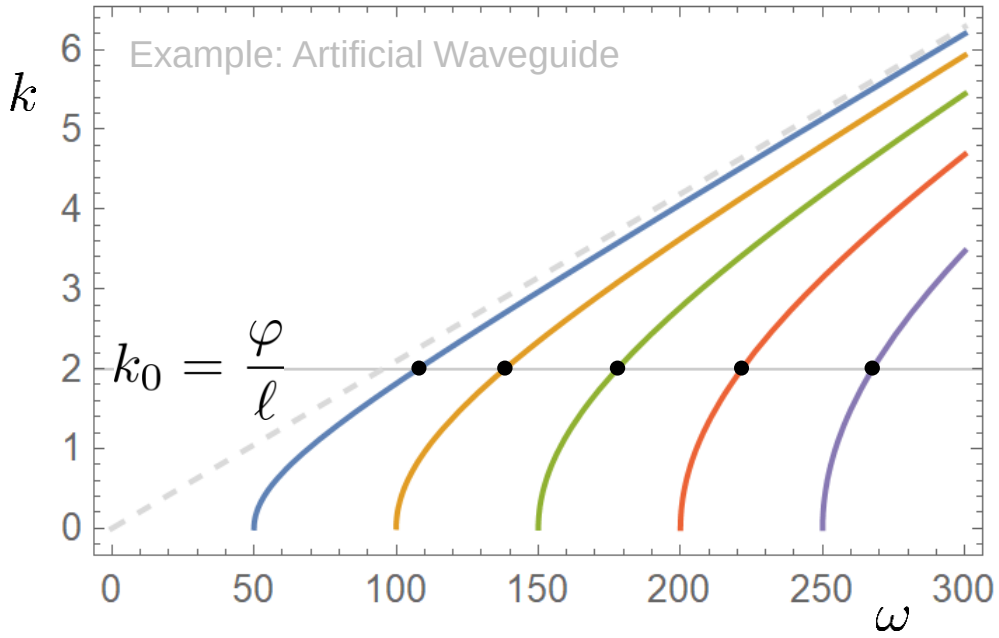
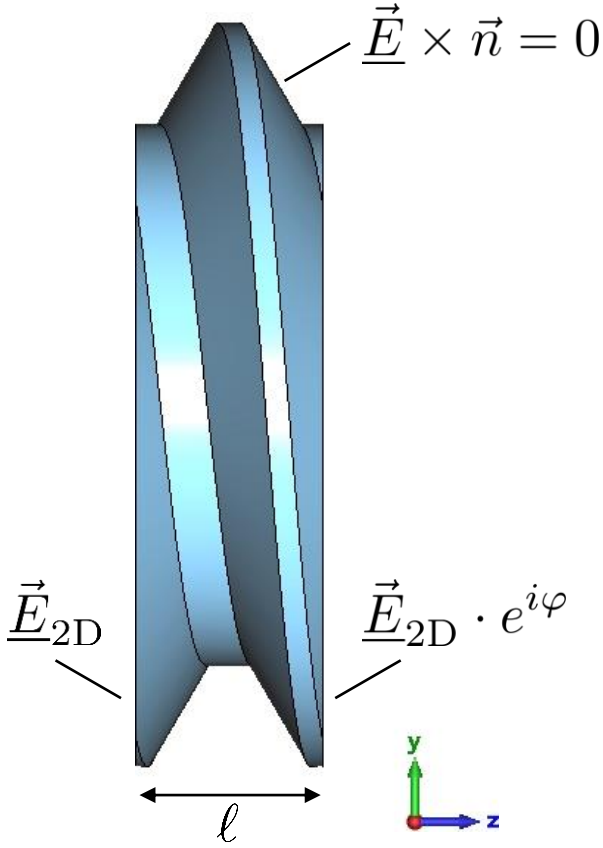
Dispersion Diagram





Numerical Modeling

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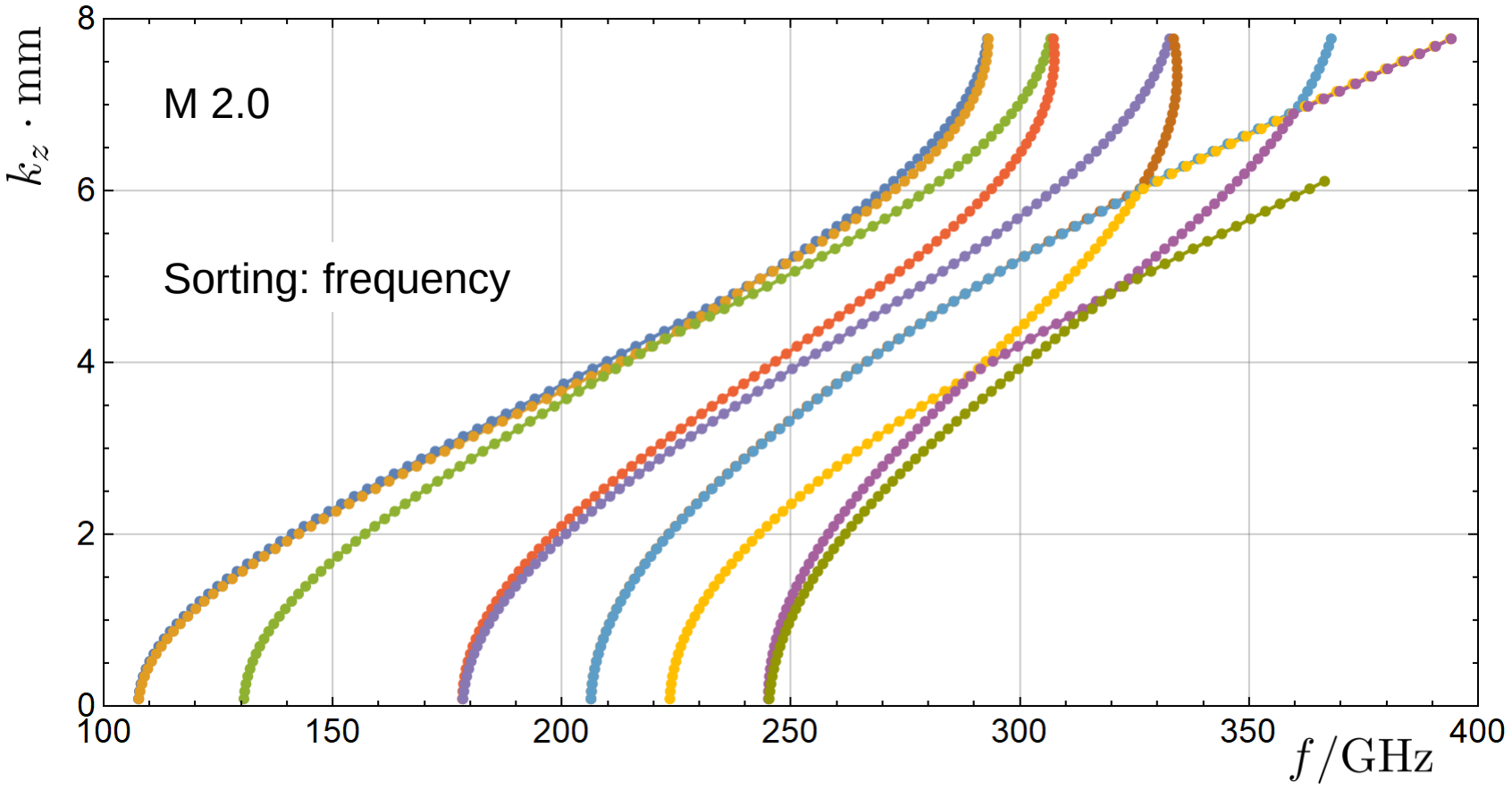
- Dispersion Diagram (ISO metric screw thread)



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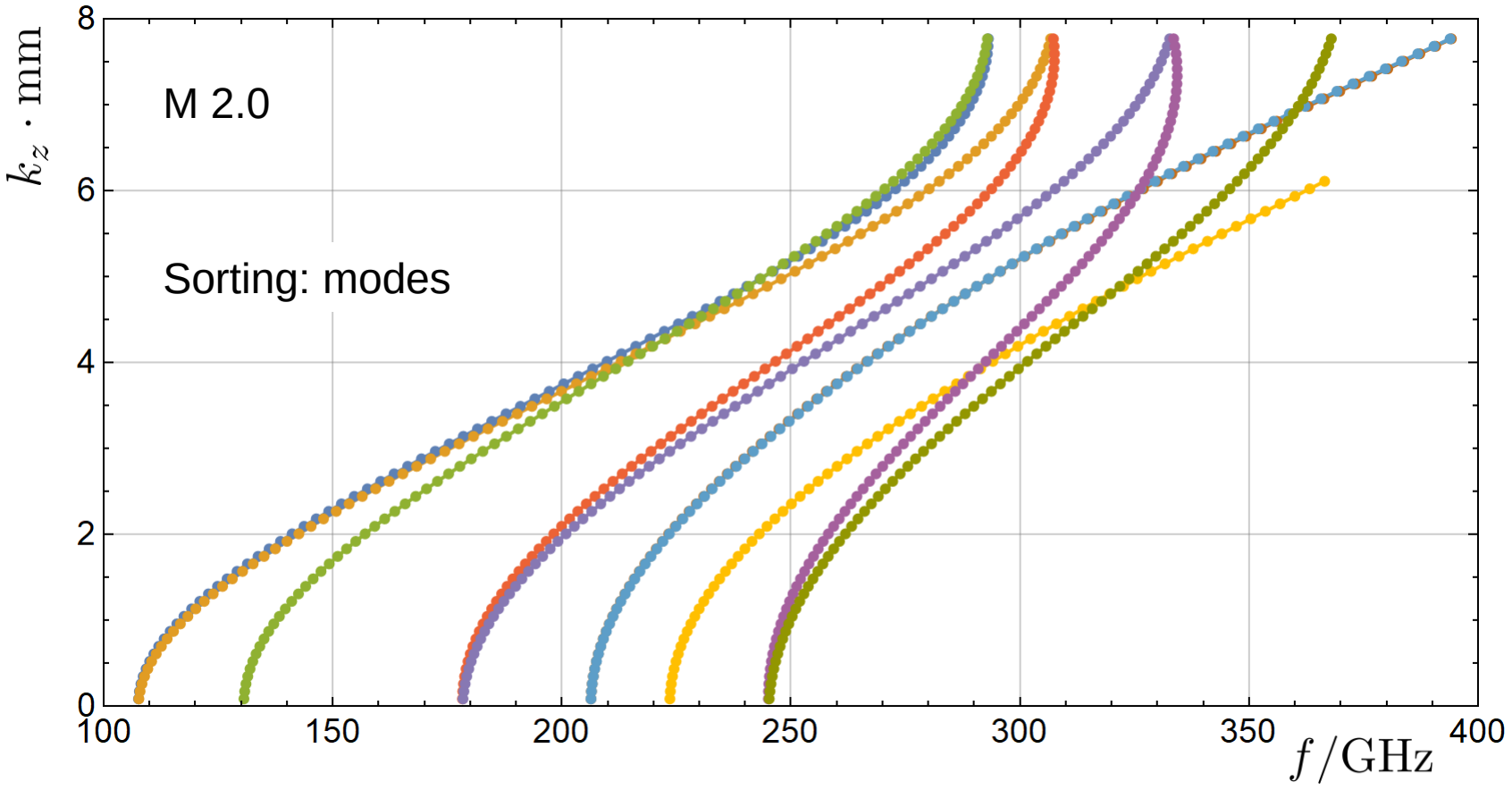

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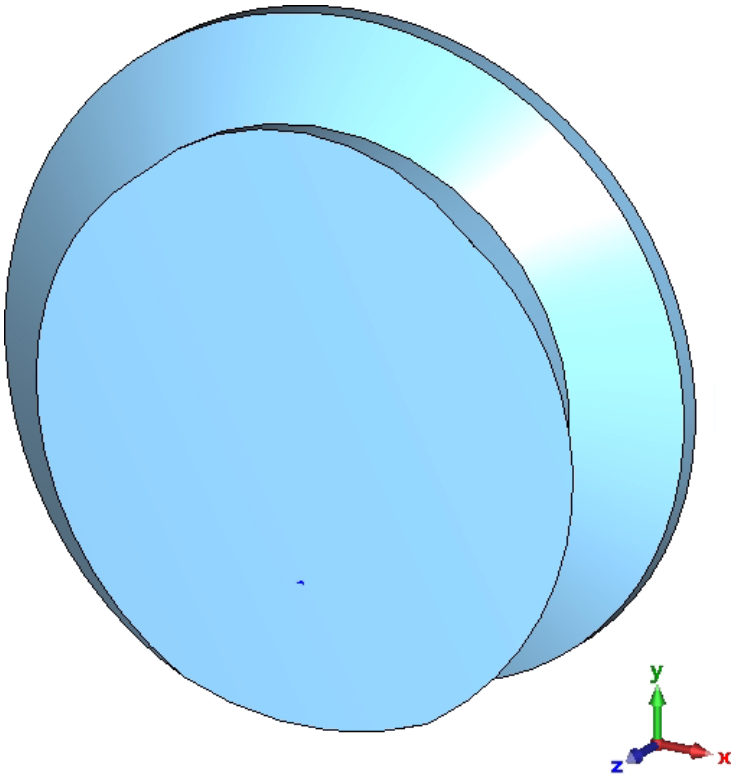

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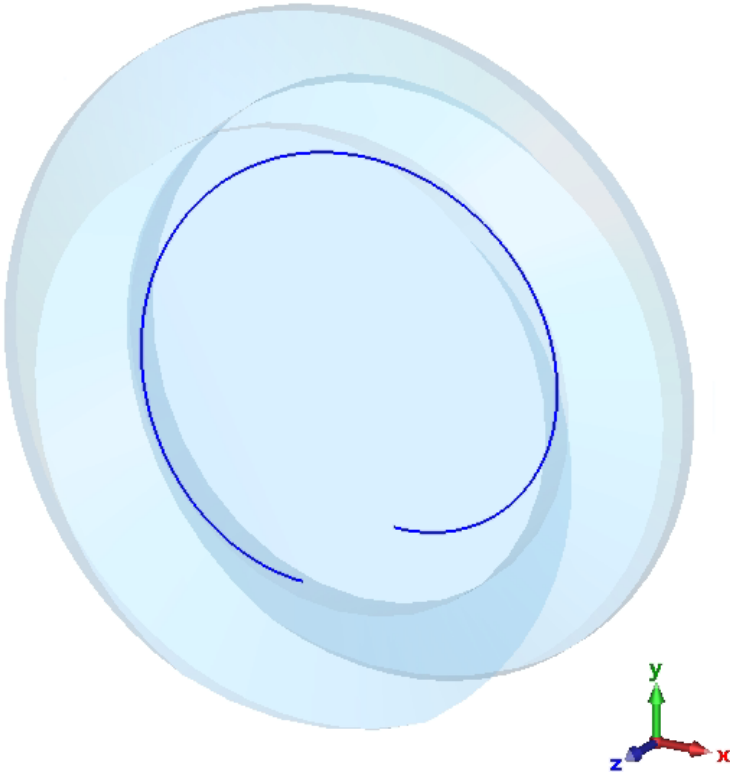

Field Evaluation Path (Helix)

Numerical Modeling

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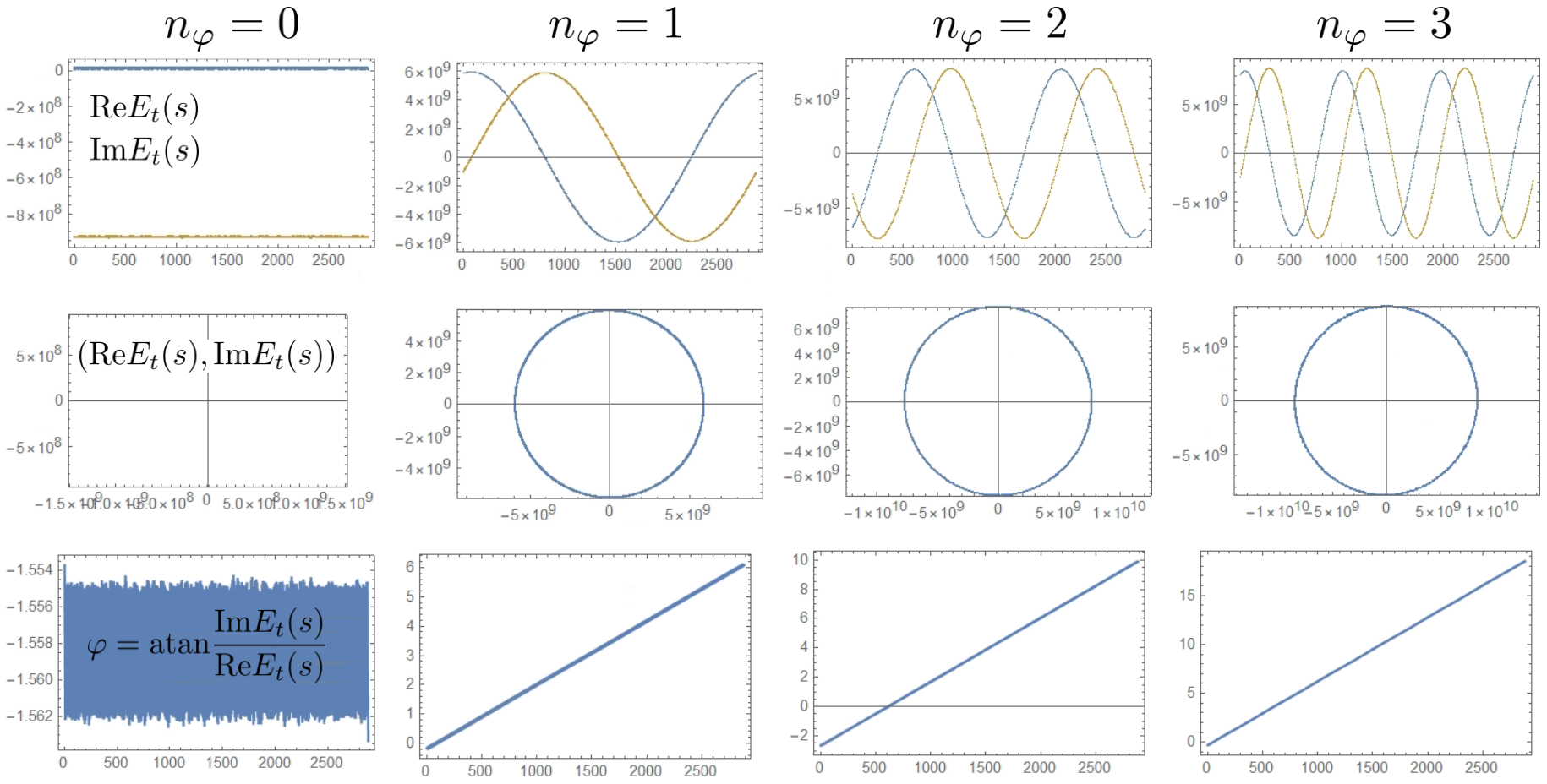
- Determination of the Azimuthal Order



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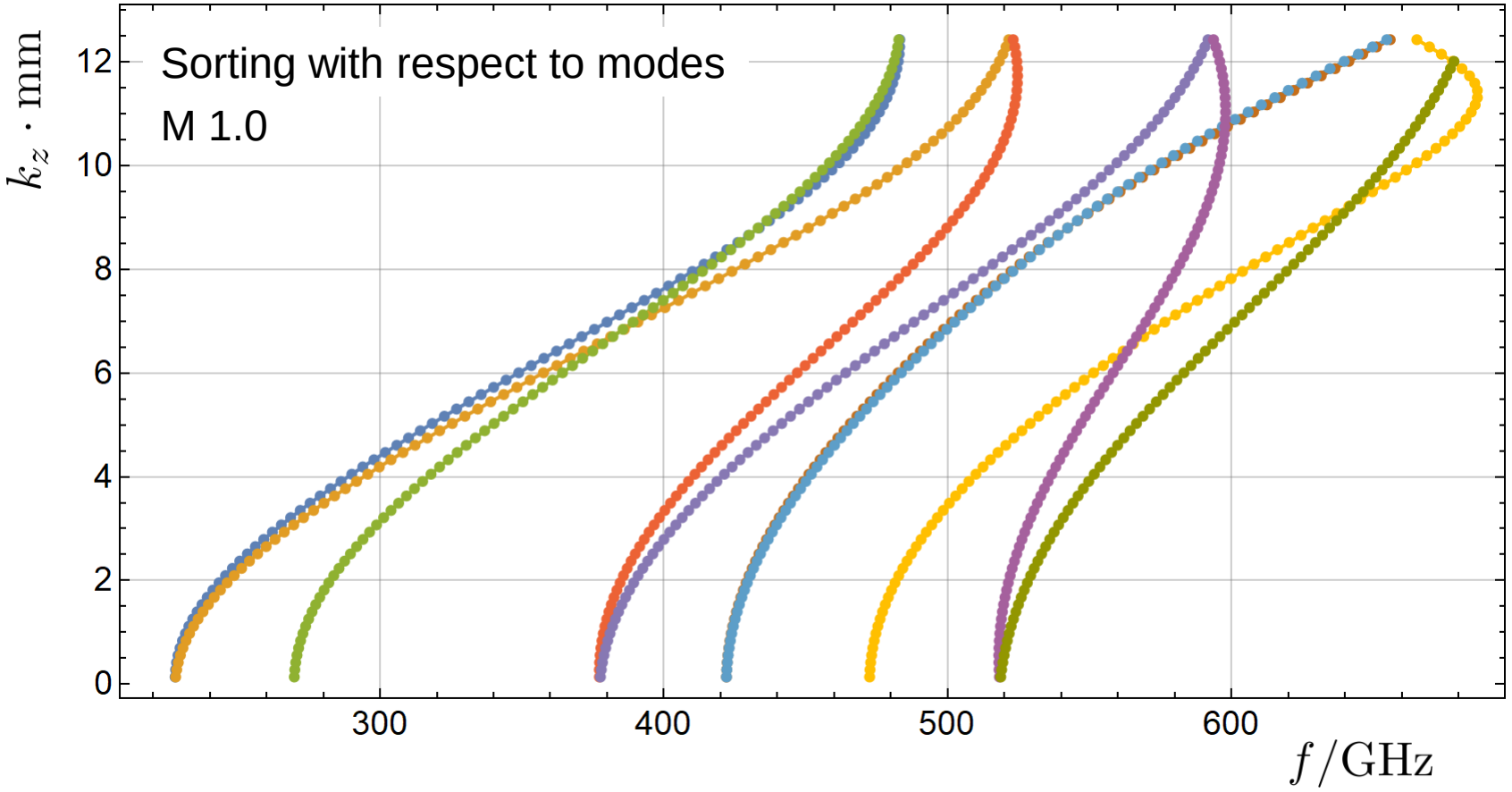

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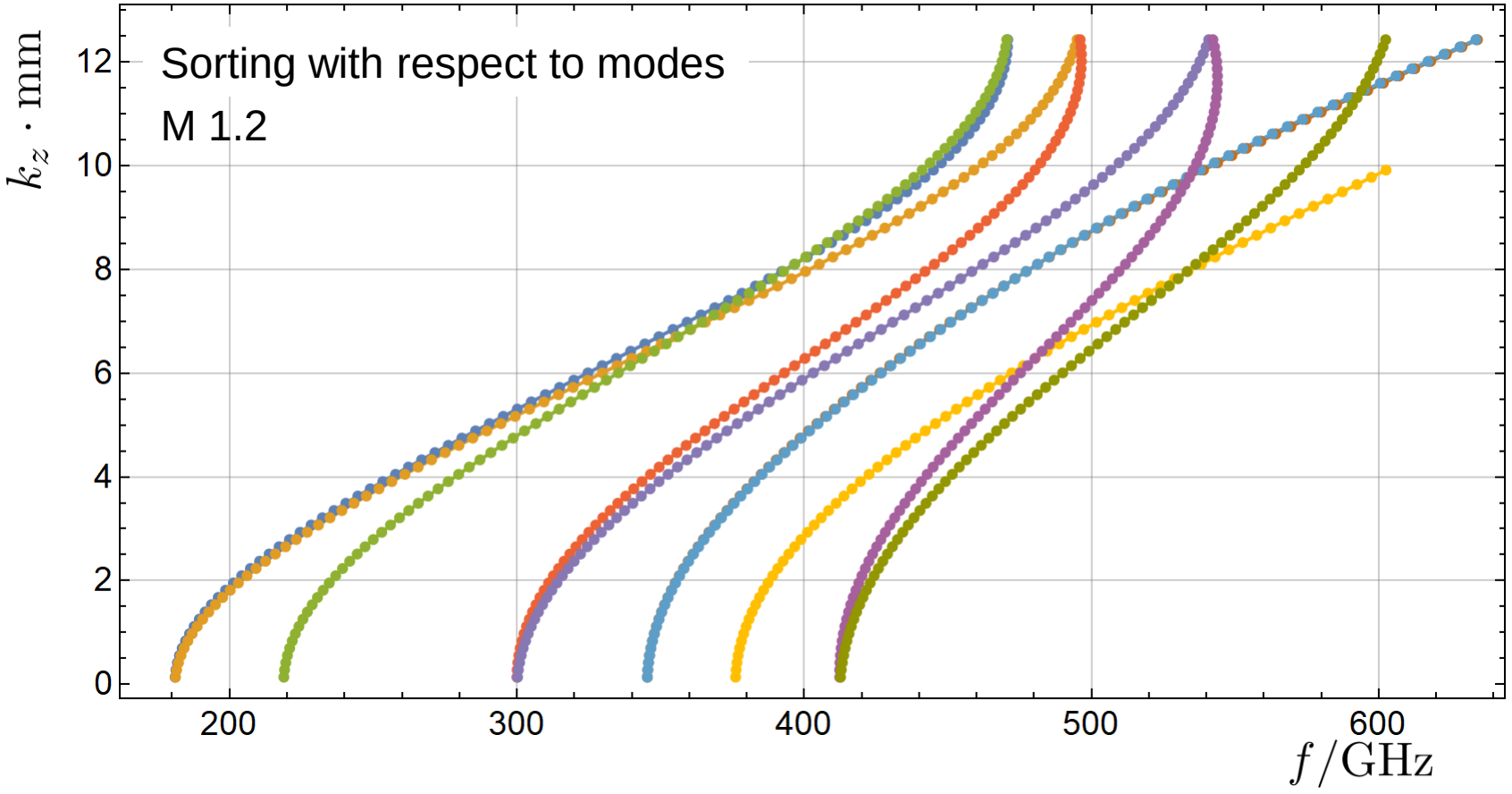

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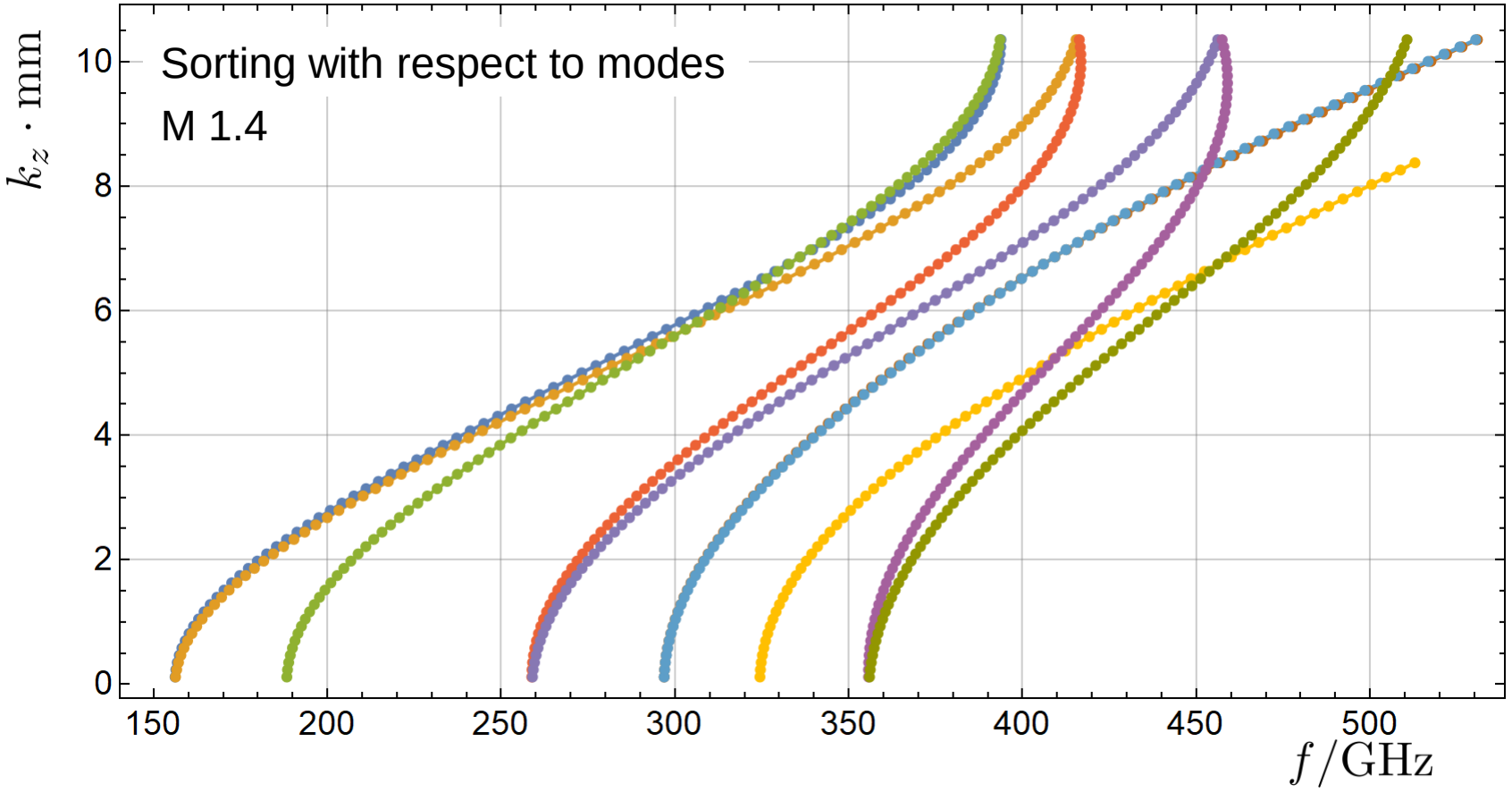

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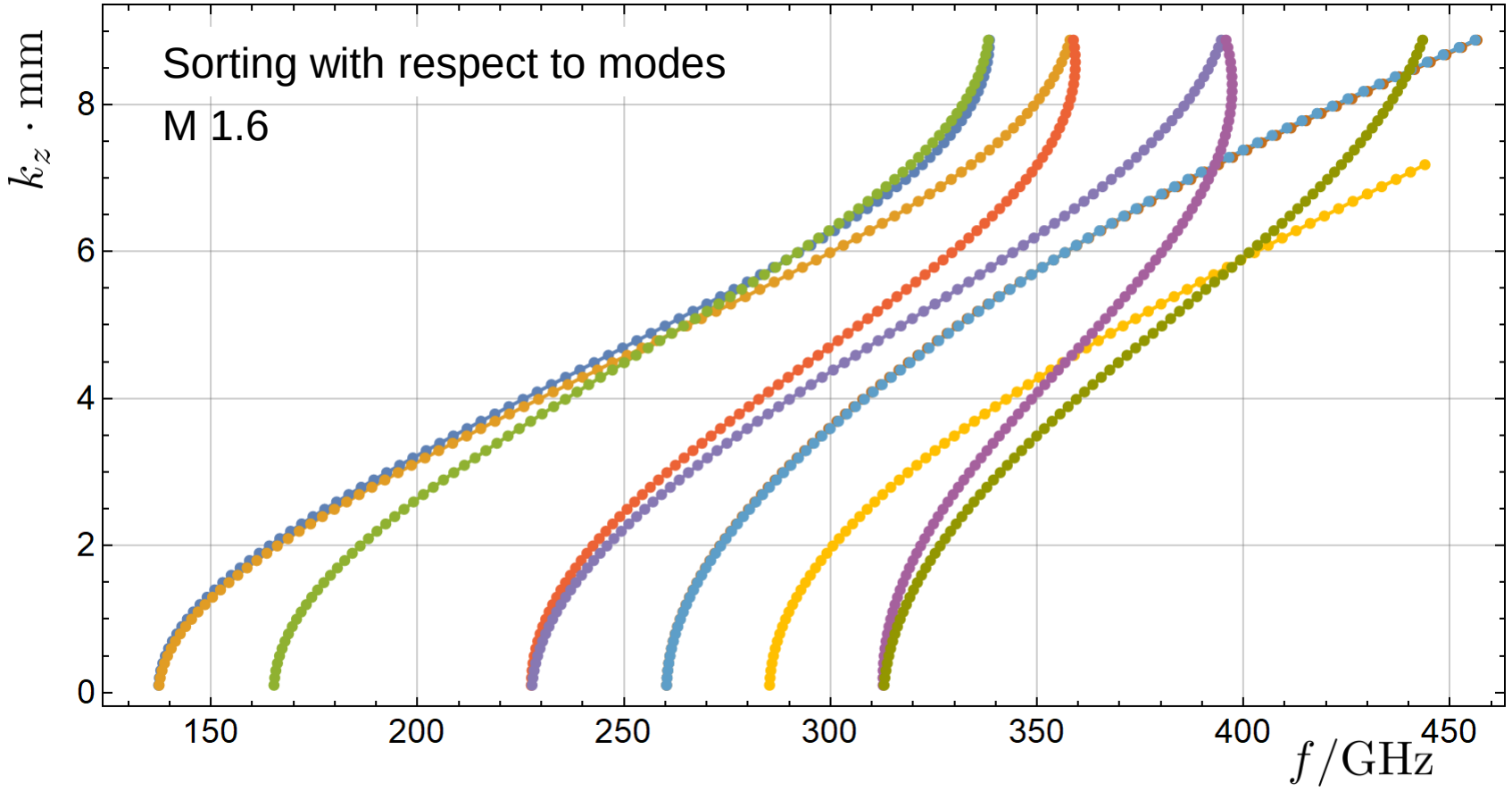

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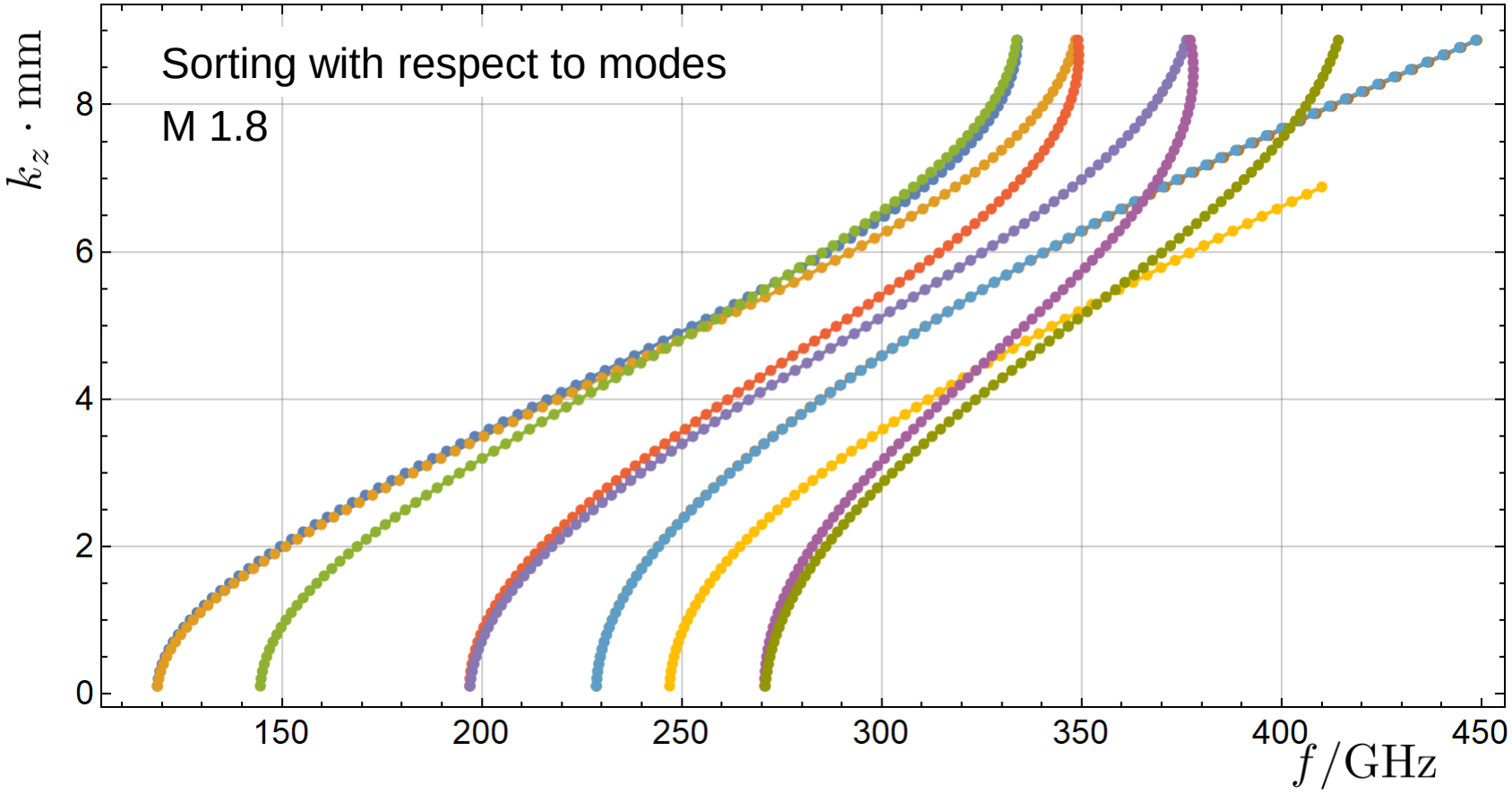

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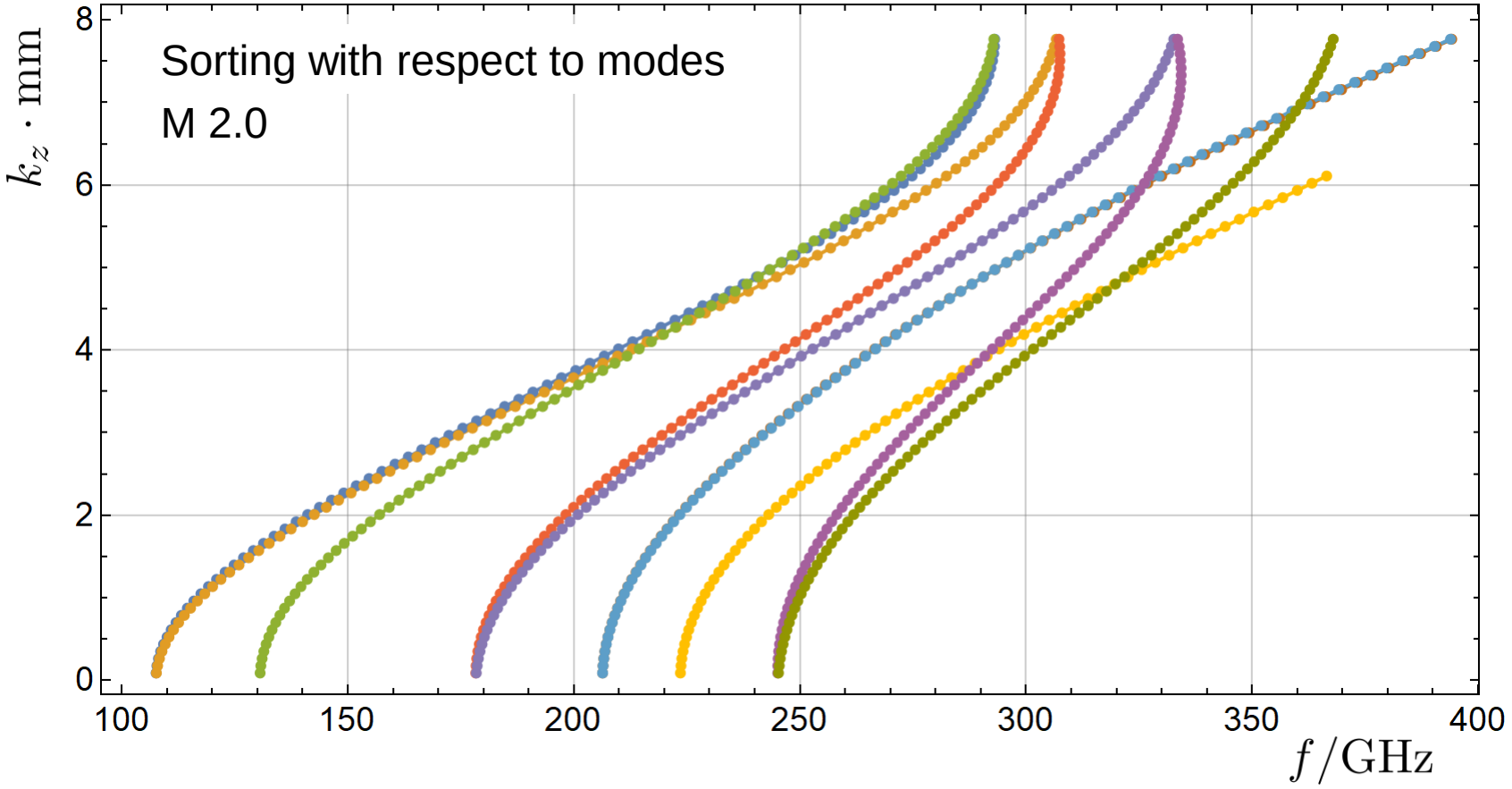

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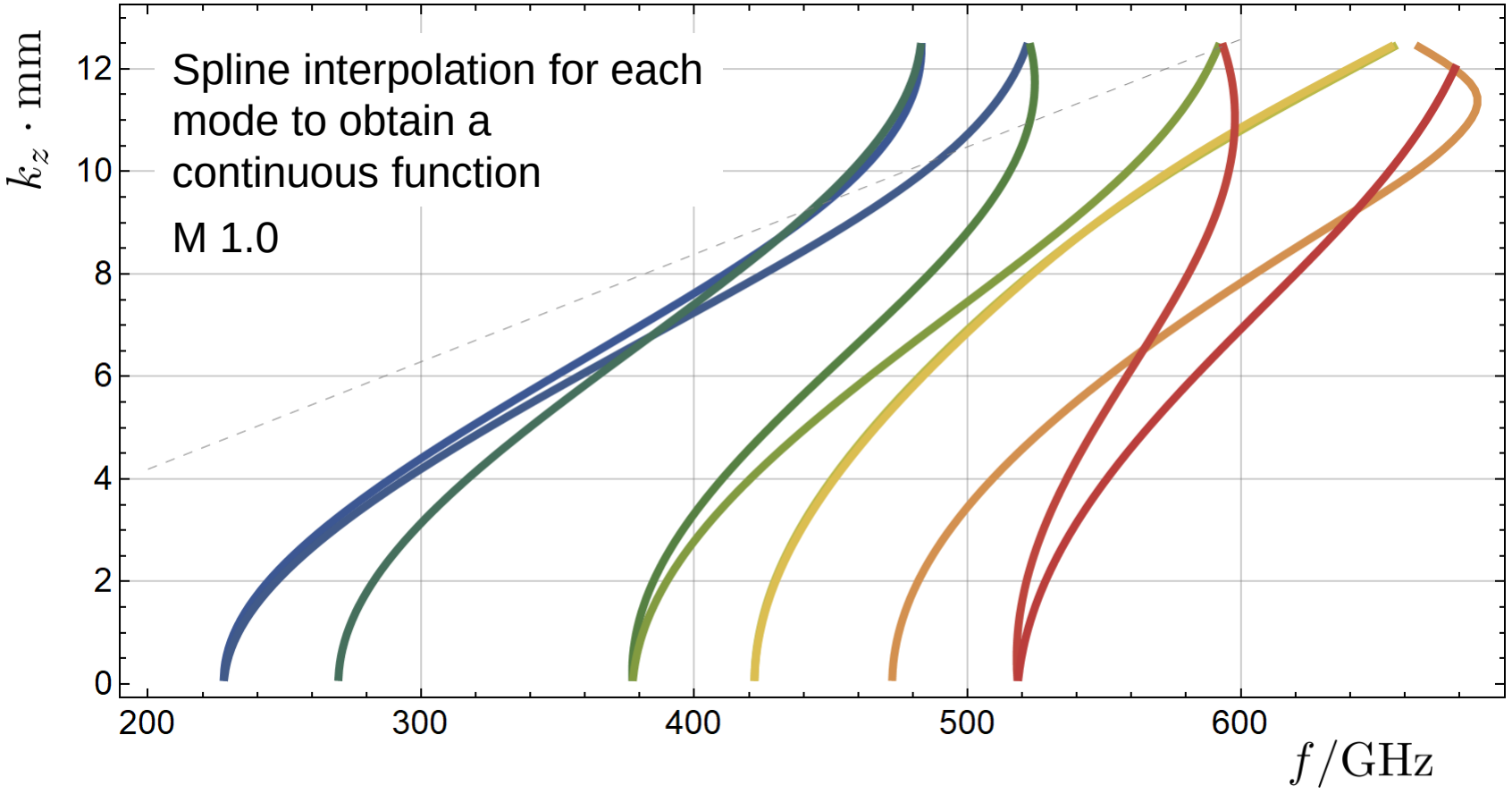

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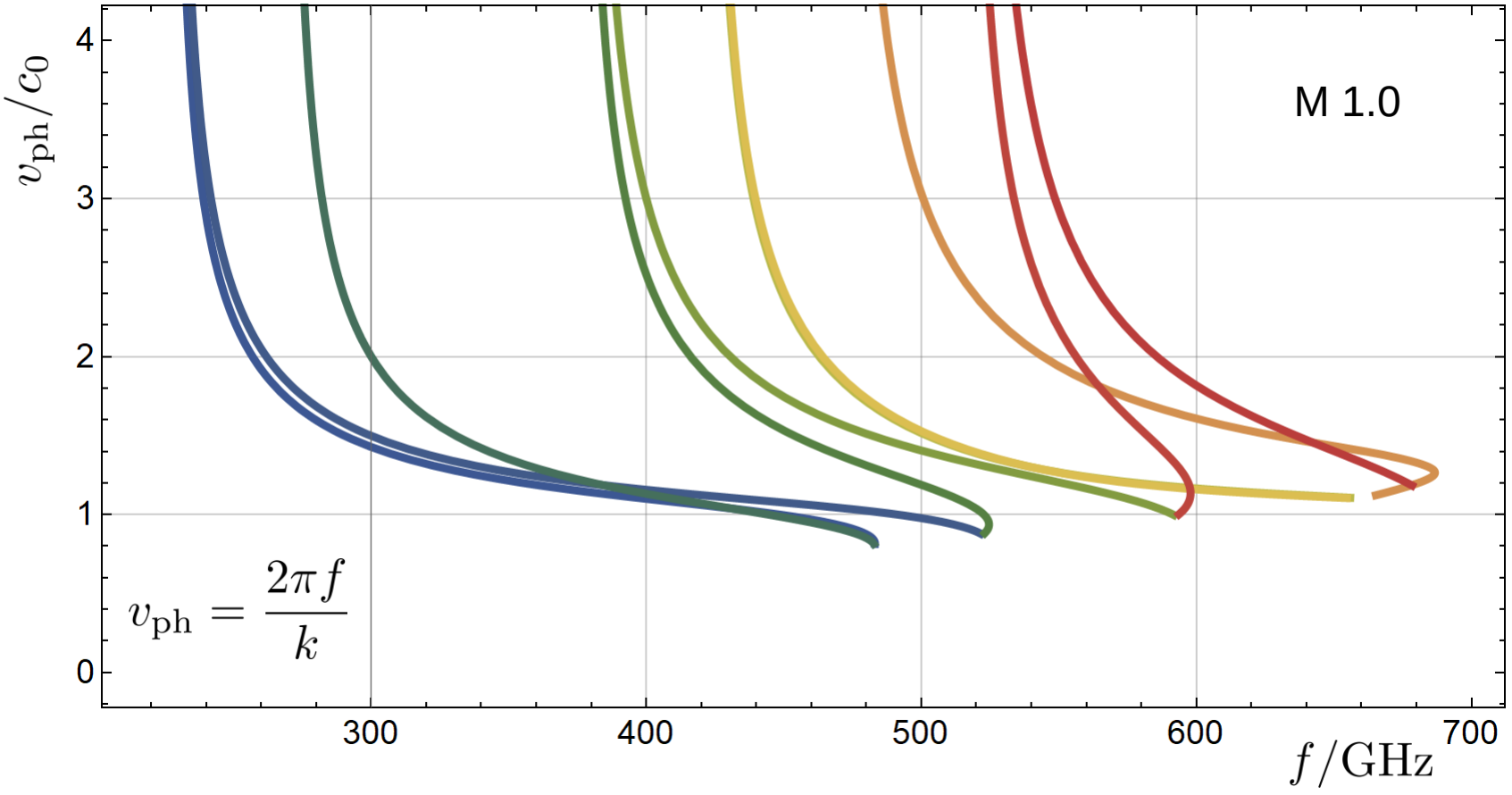

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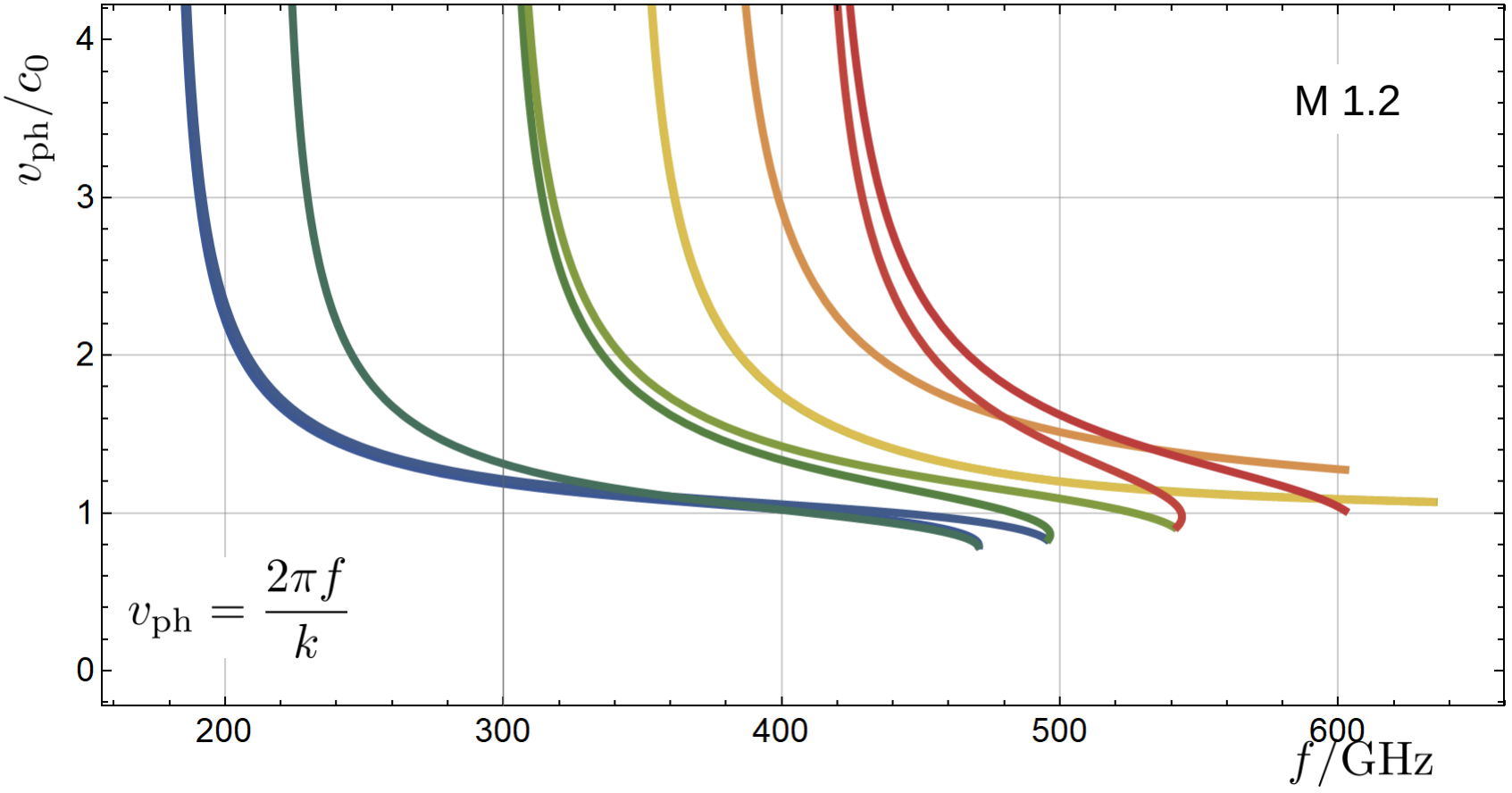

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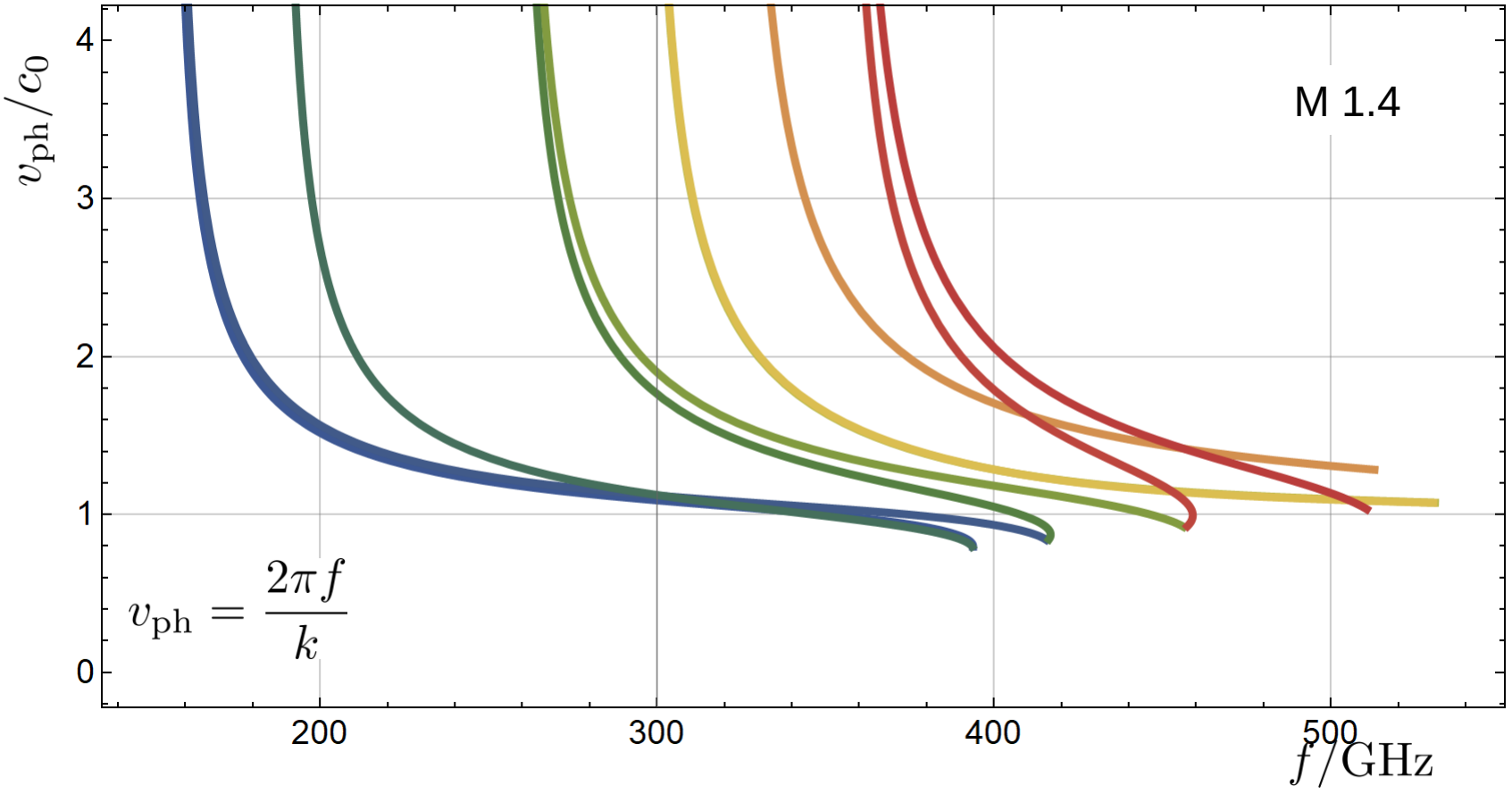

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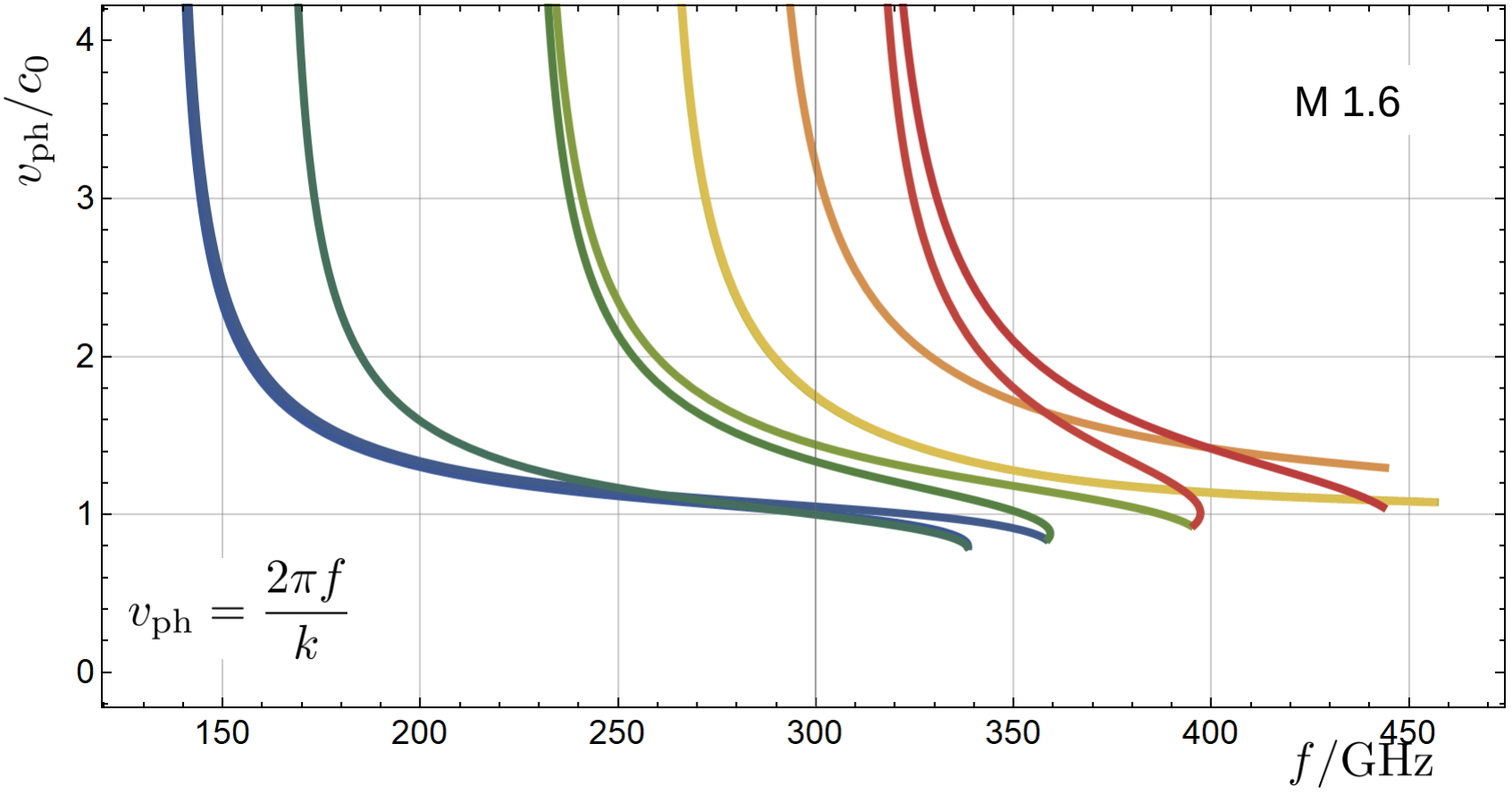

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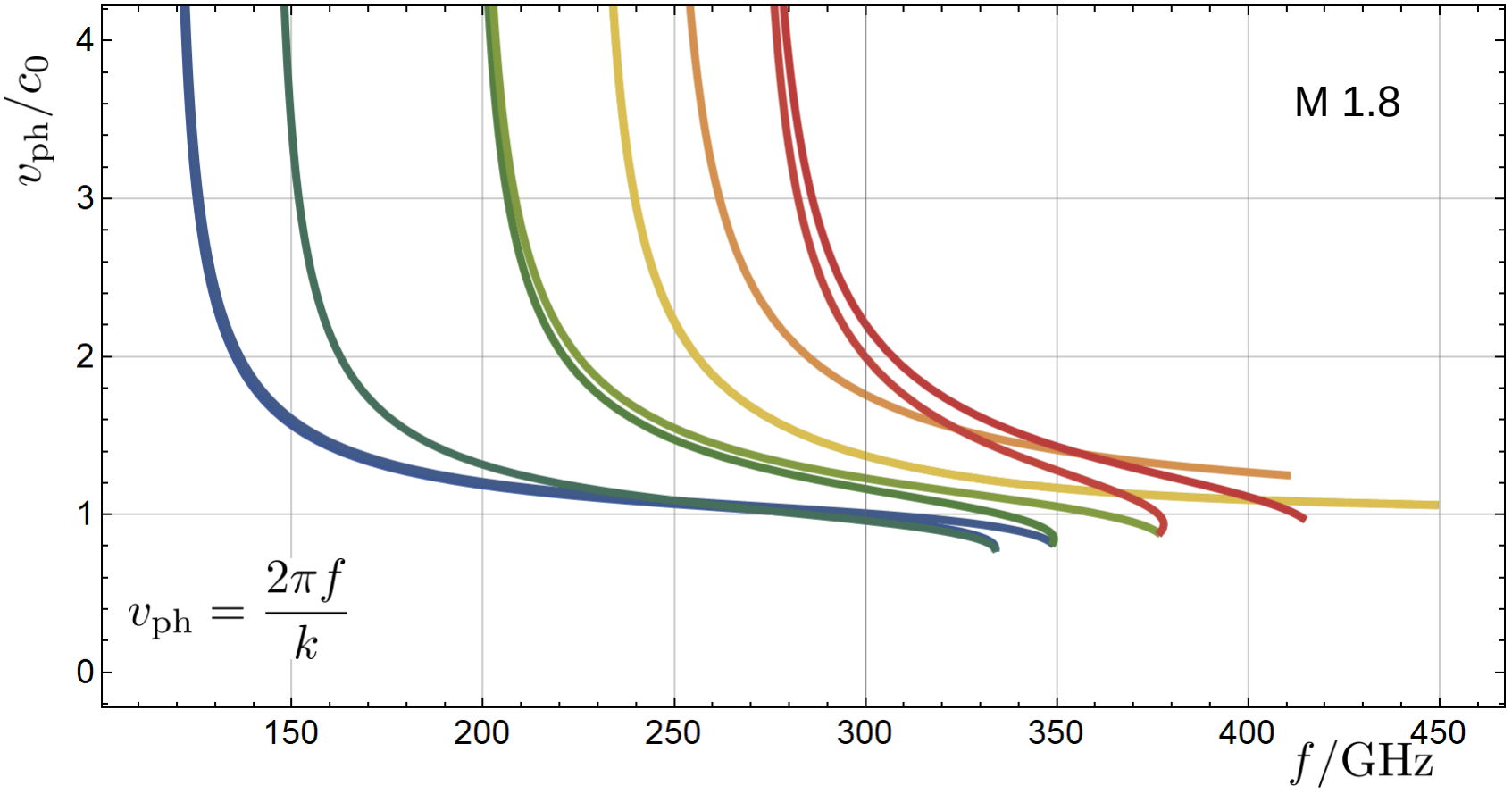

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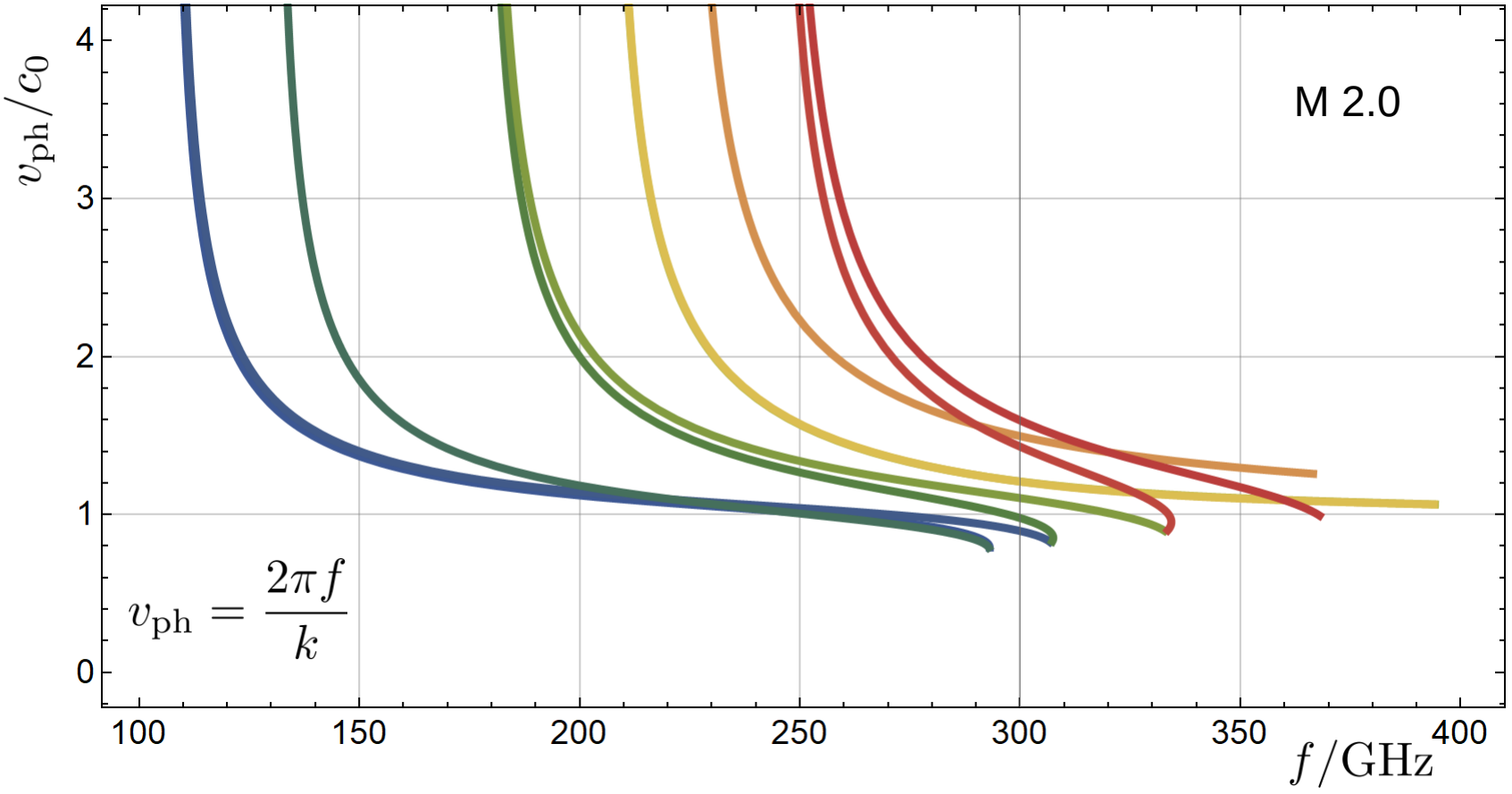

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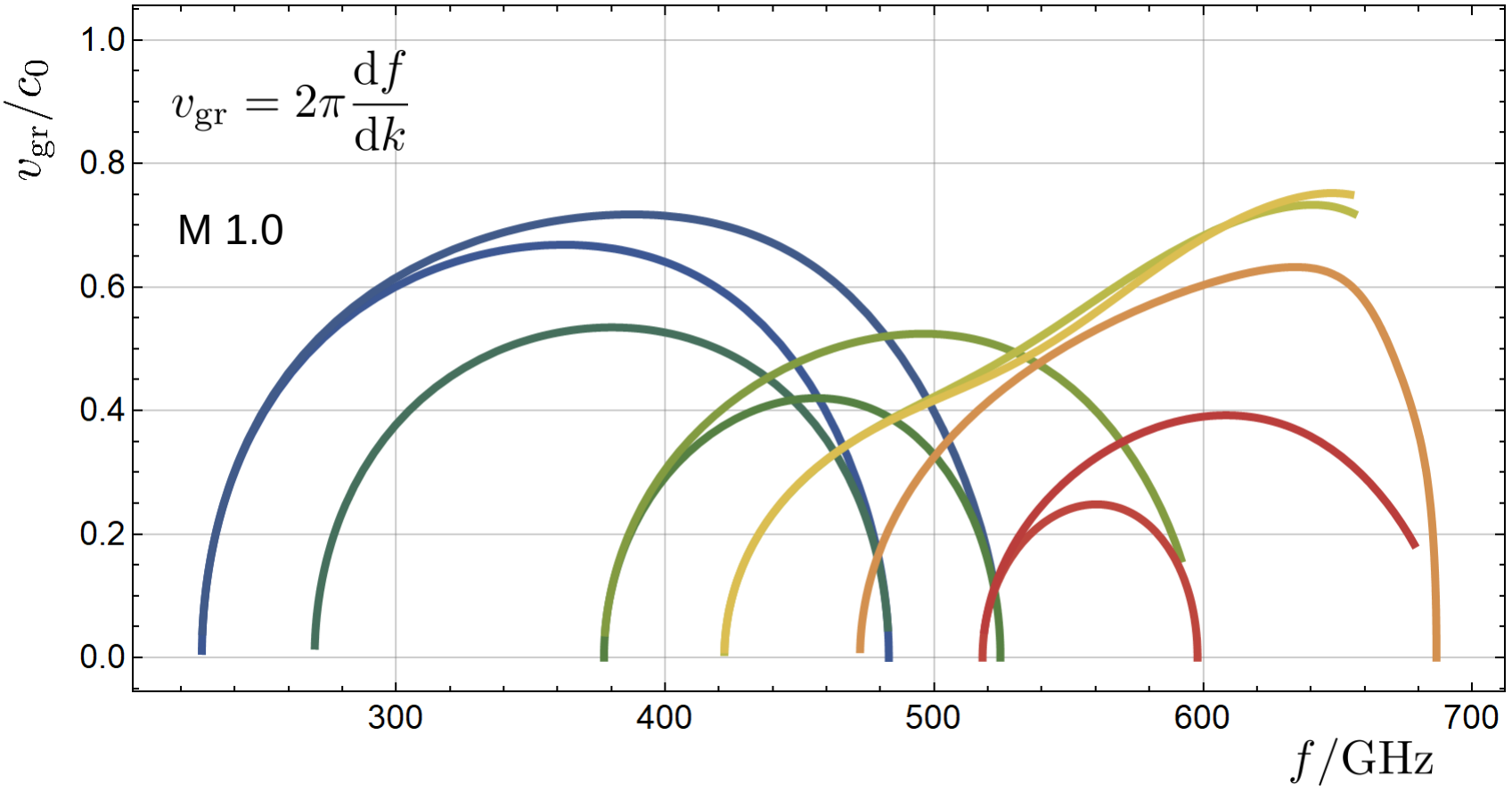

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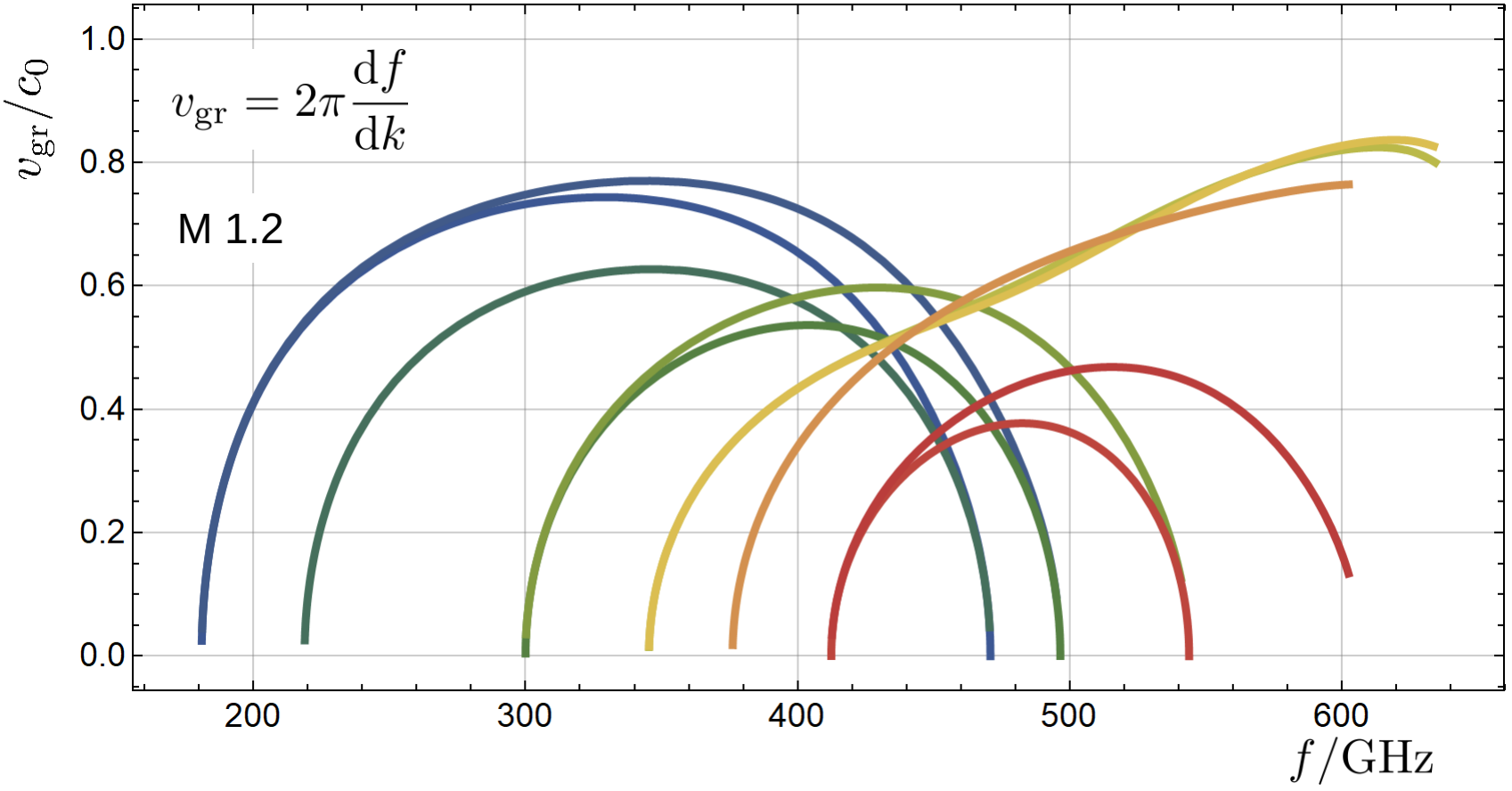

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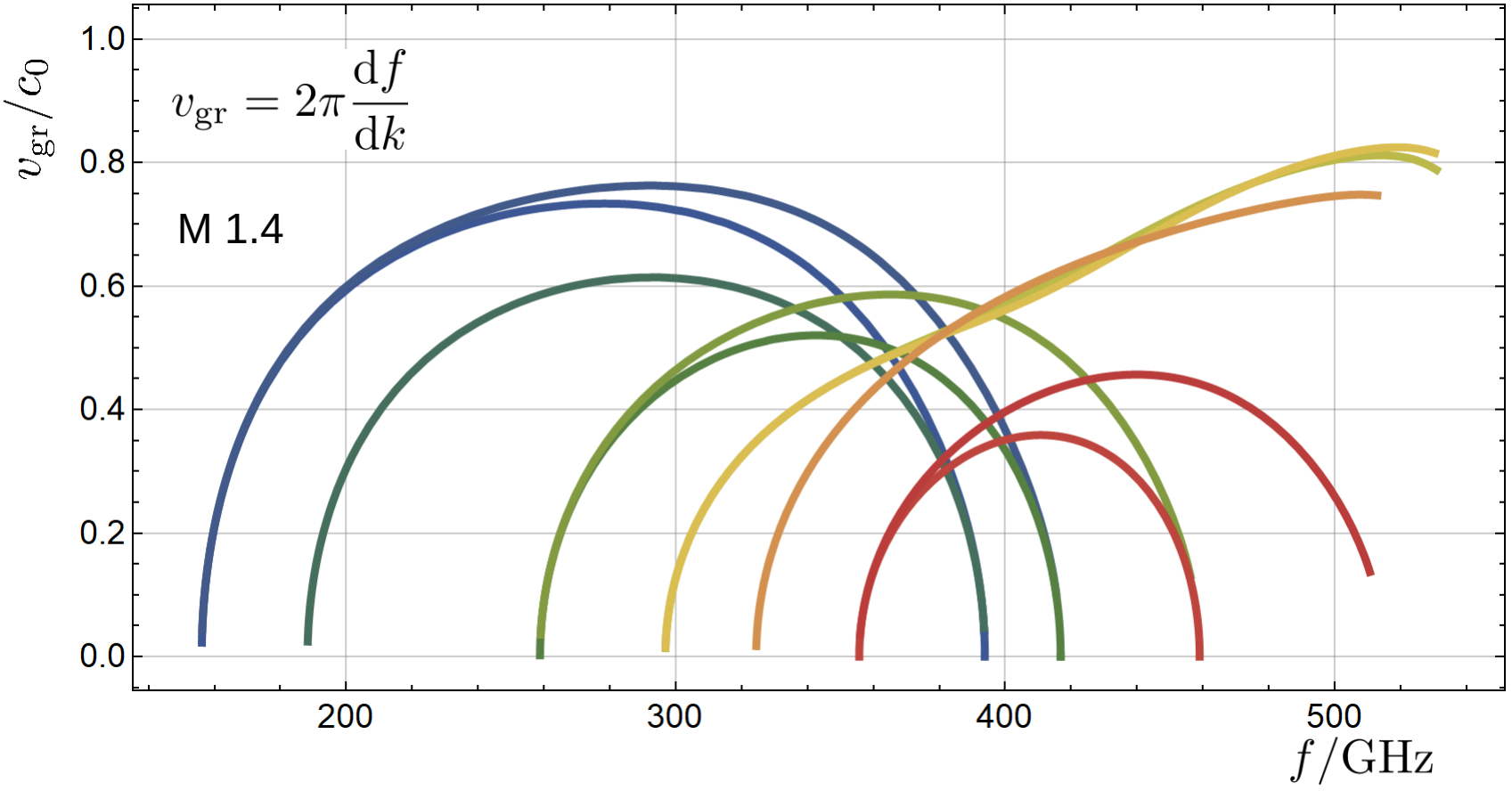

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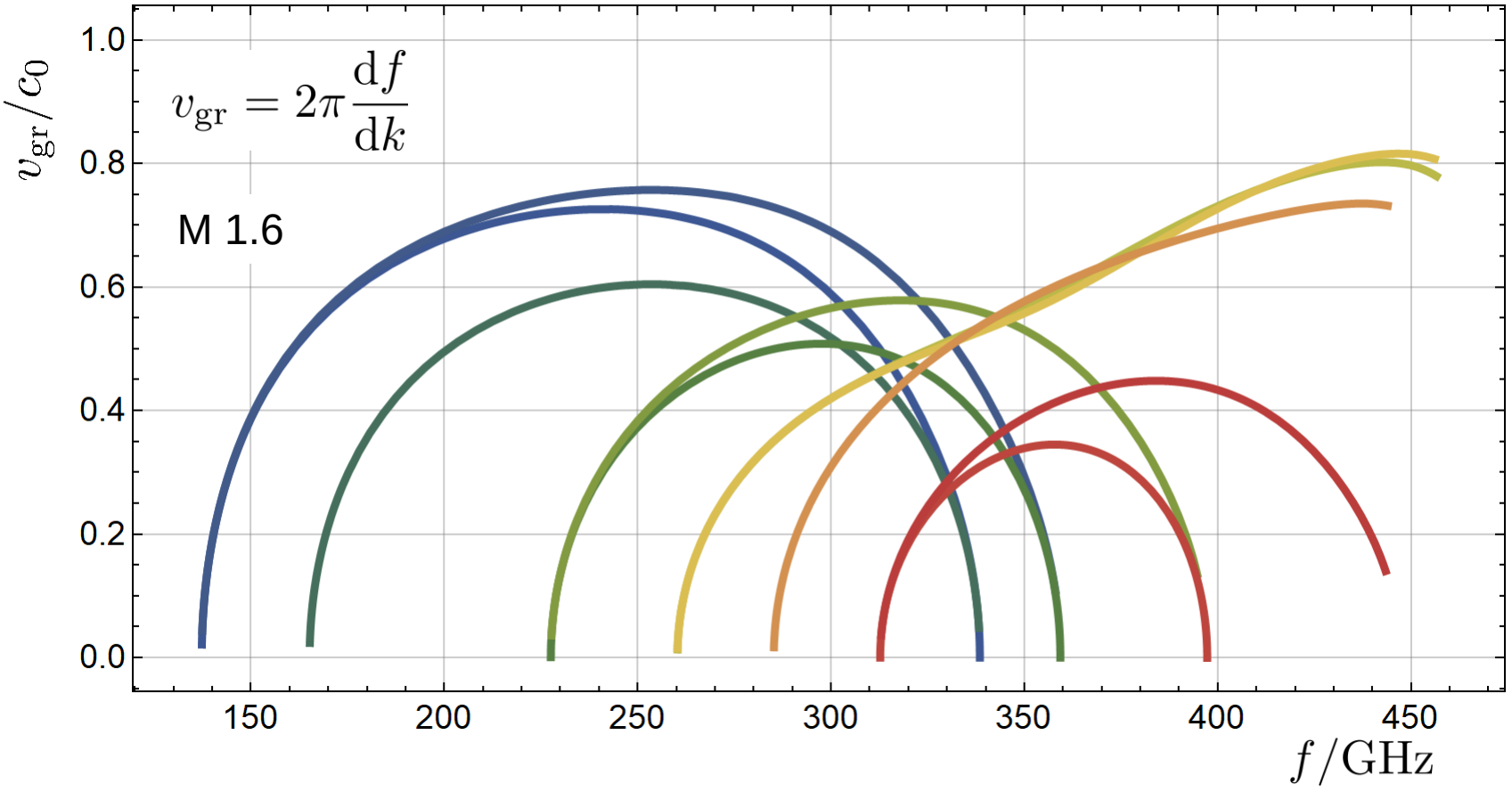

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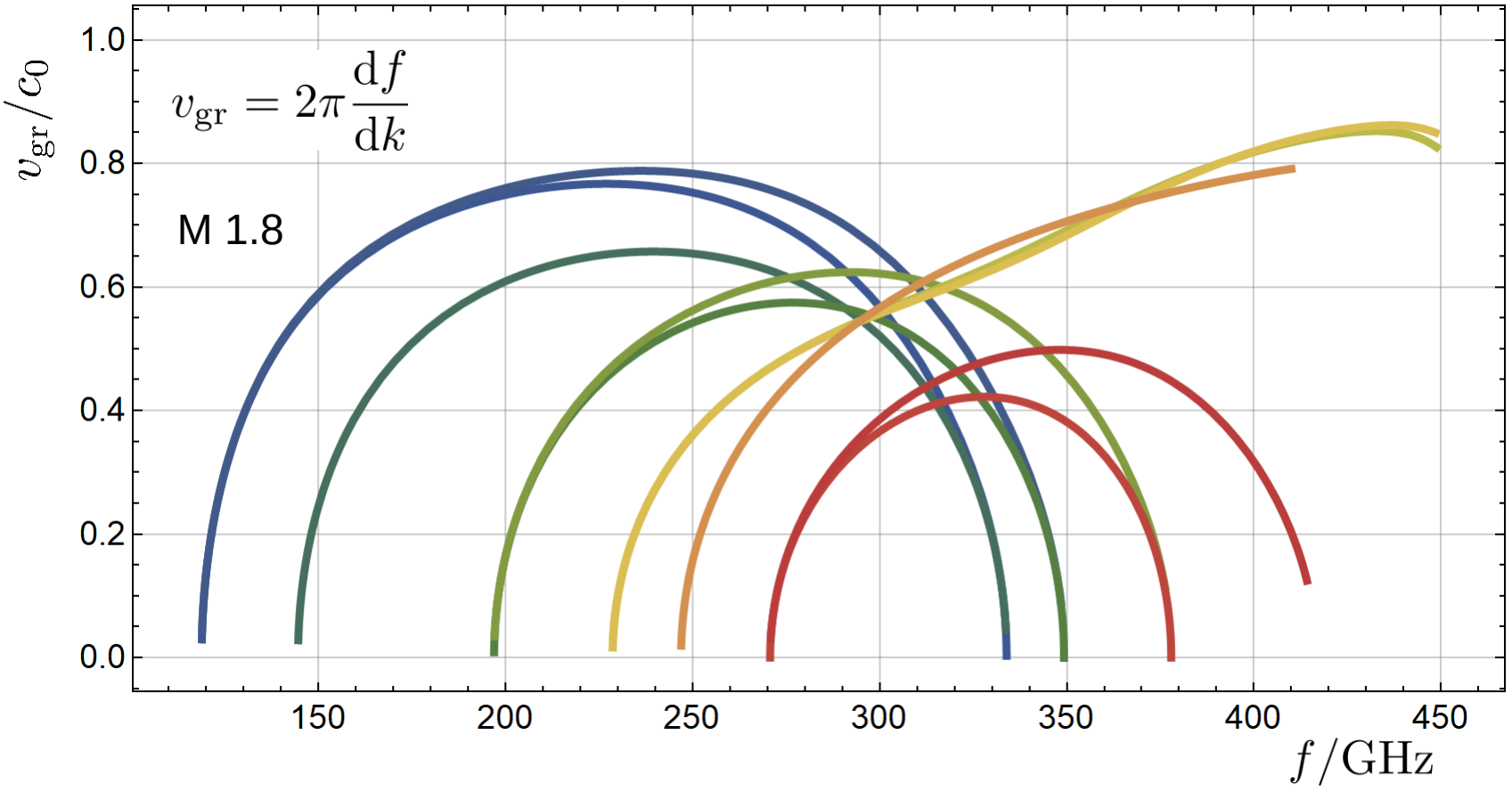

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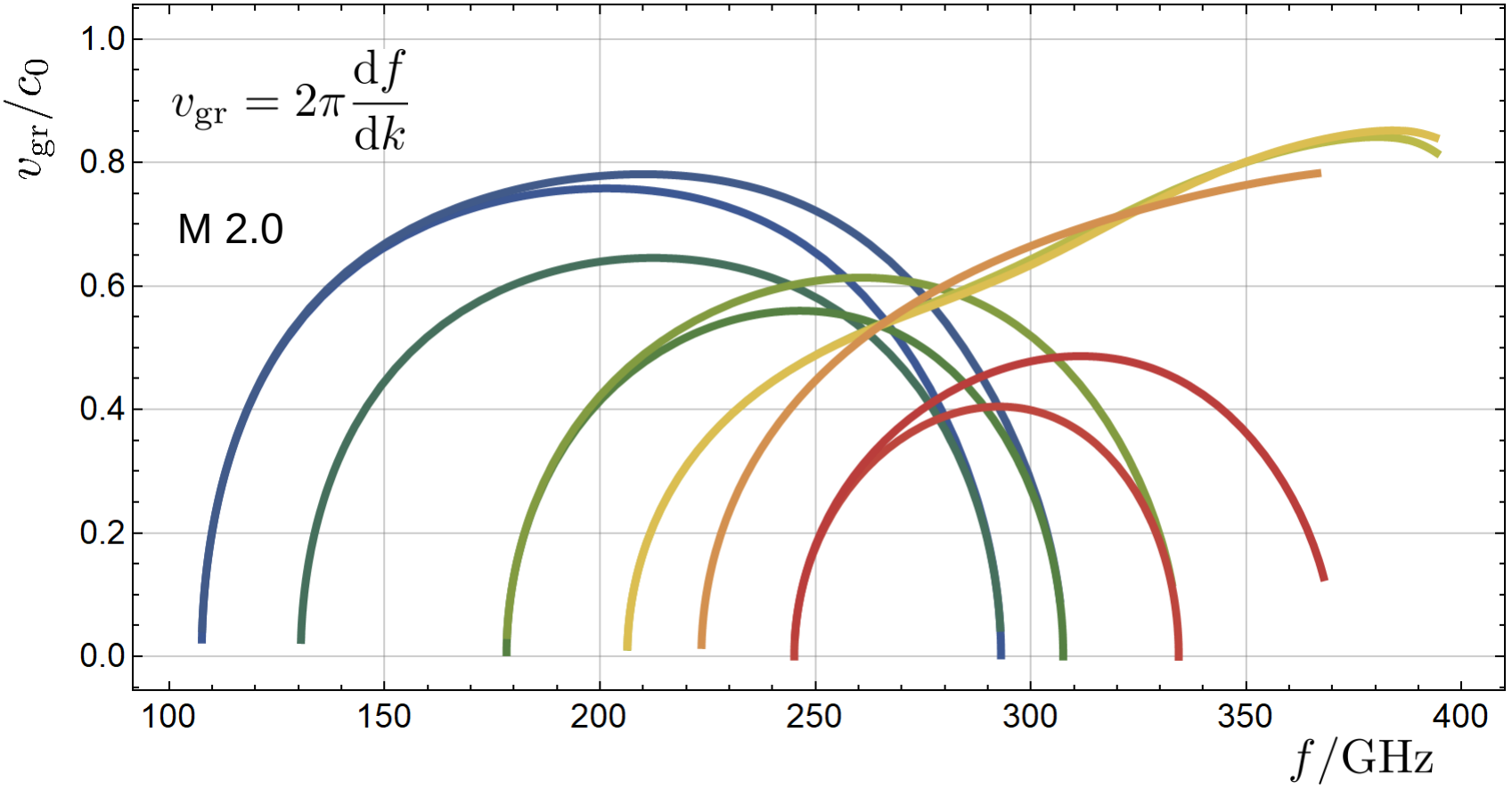

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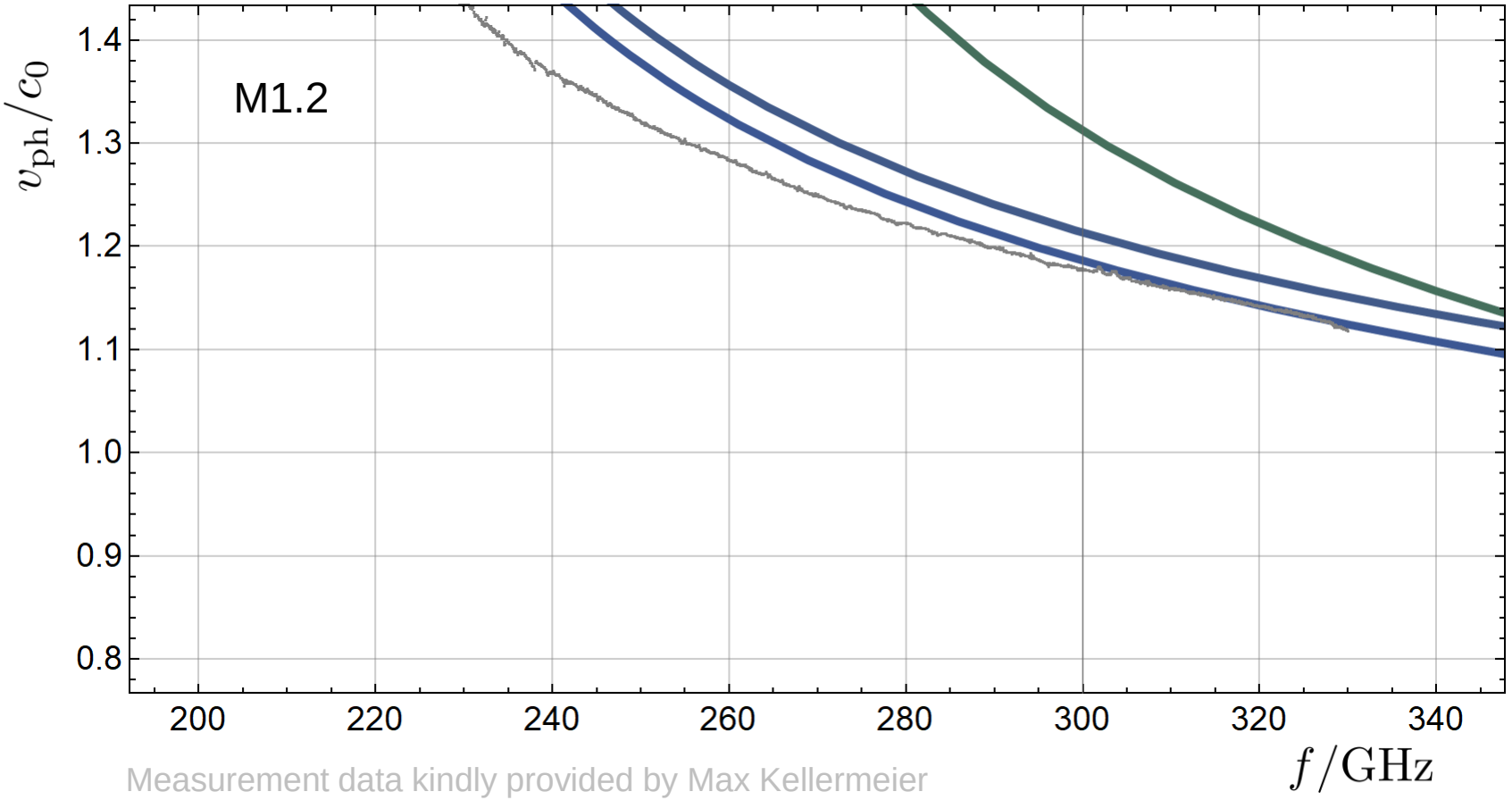

Measurement data kindly provided by Max Kellermeier

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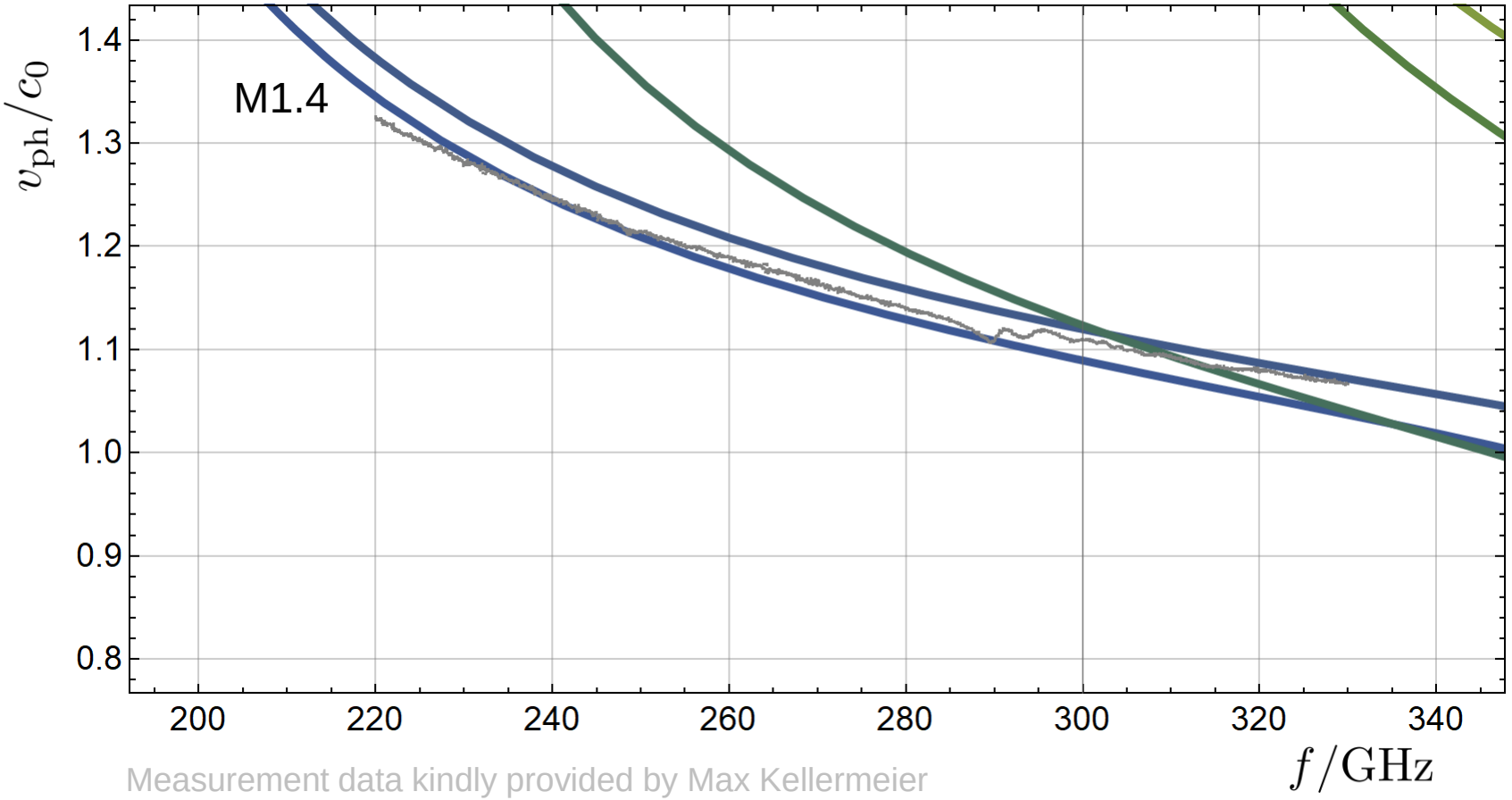

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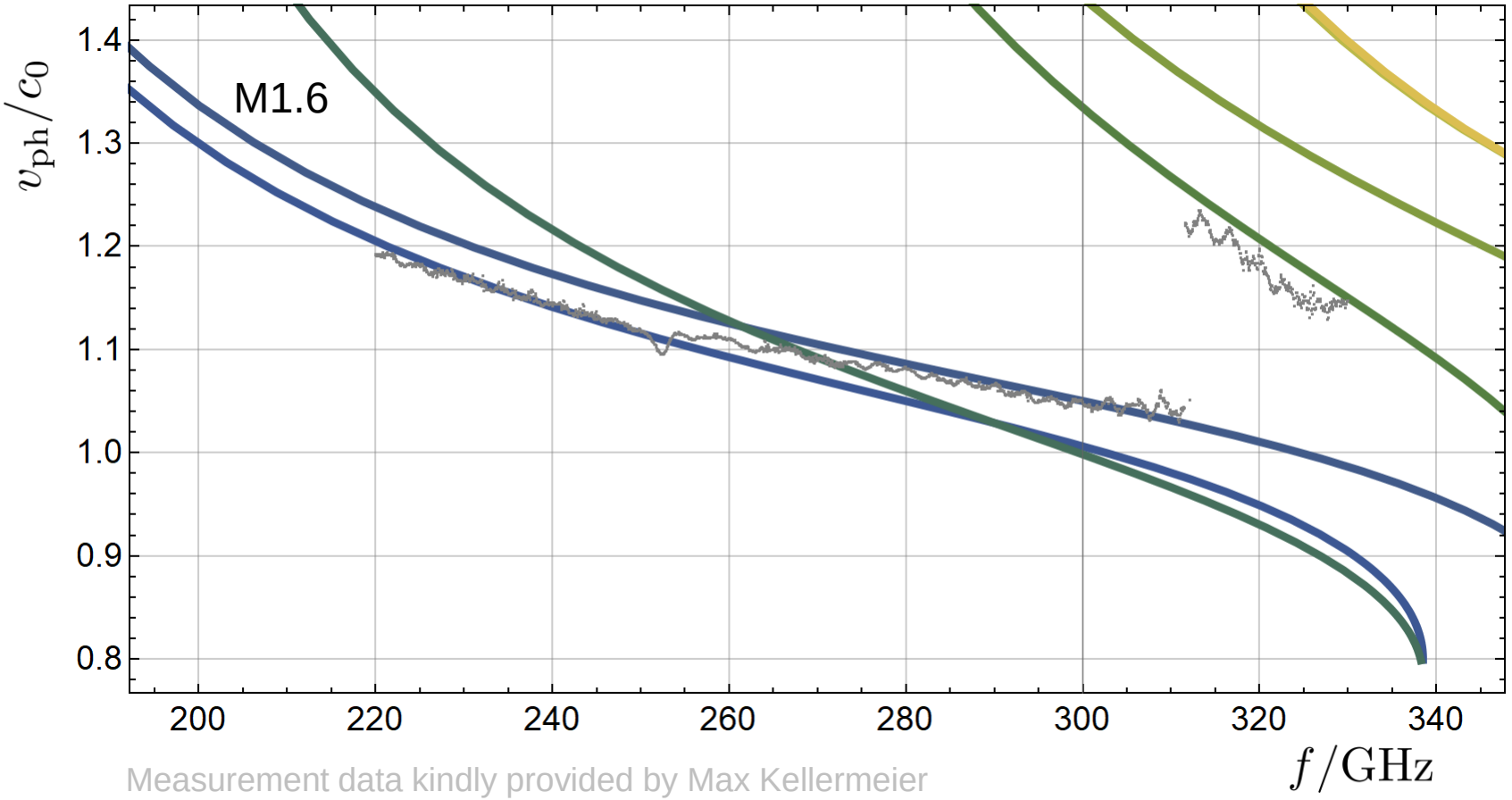

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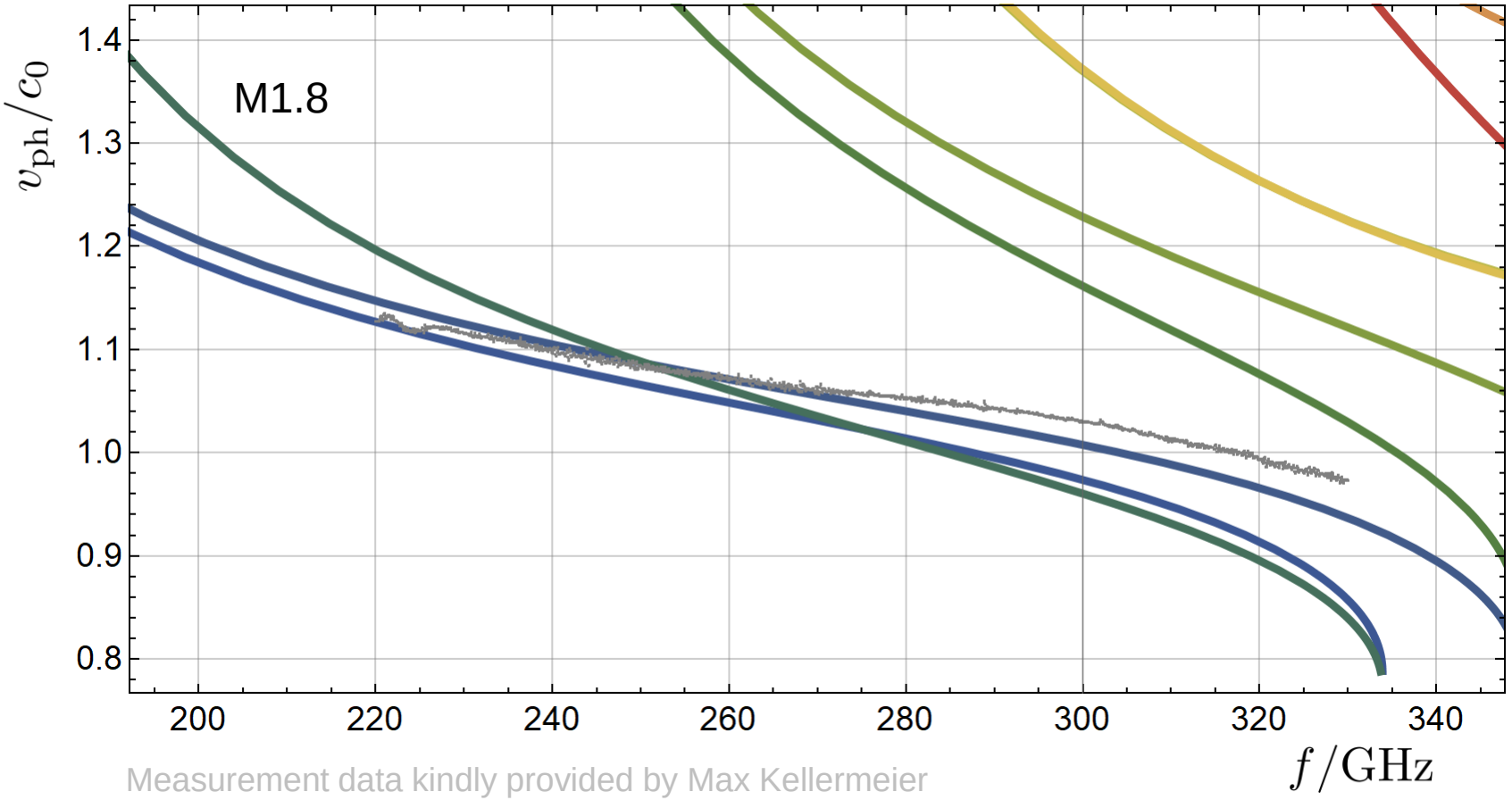

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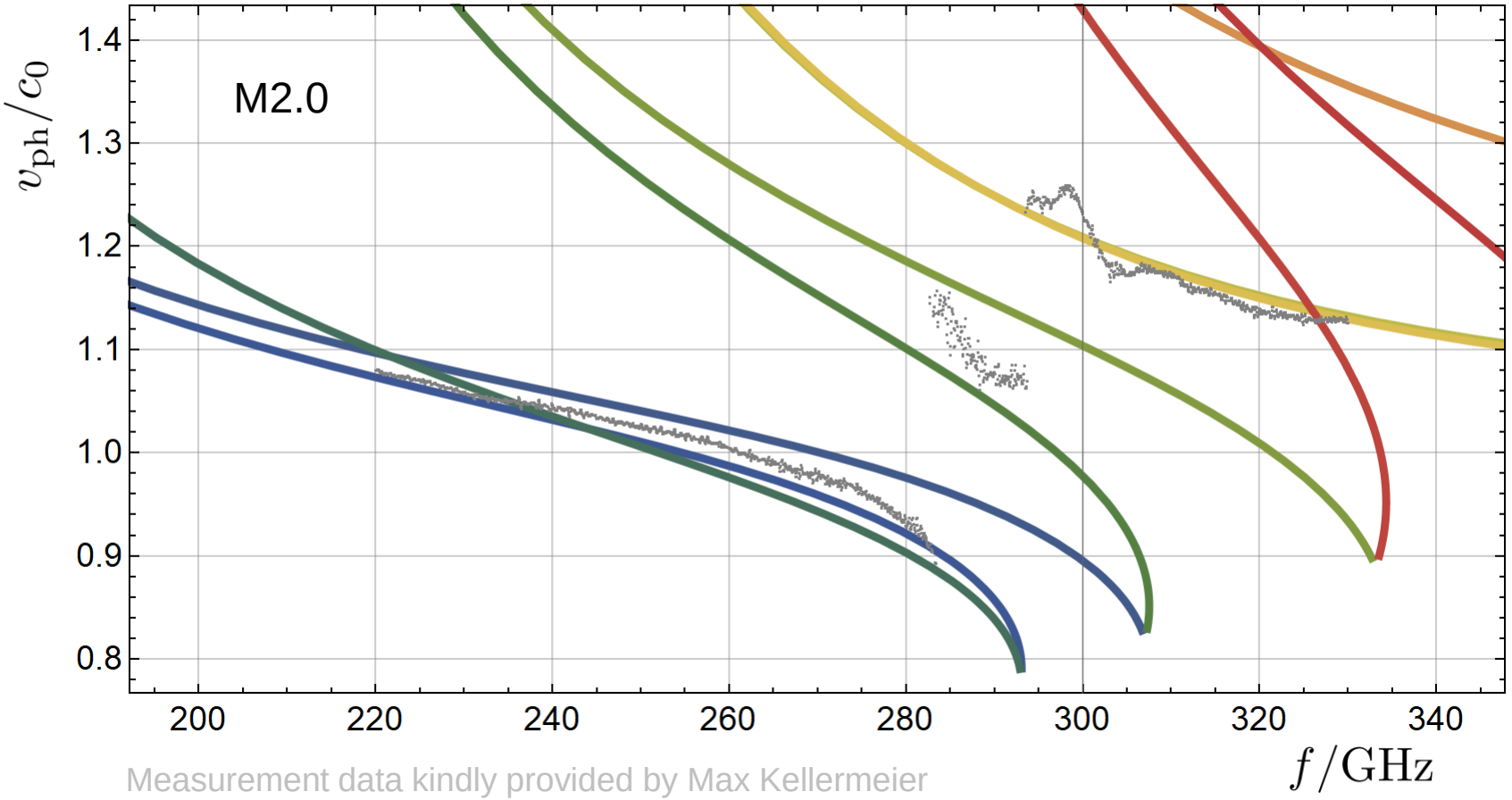

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Summary and Outlook

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- Summary
  - Determination of the dispersion diagram using a 3D eigenvalue solver with phase-shifted boundary conditions
  - Sorting of the results in terms of modes instead of the natural frequency
  - Postprocessing of the raw data to obtain phase and group velocities
- Outlook
  - Perform geometry variations to better understand the differences to the measurements
  - Waveguide mode excitation based on a particle beam