Möbius Resonators

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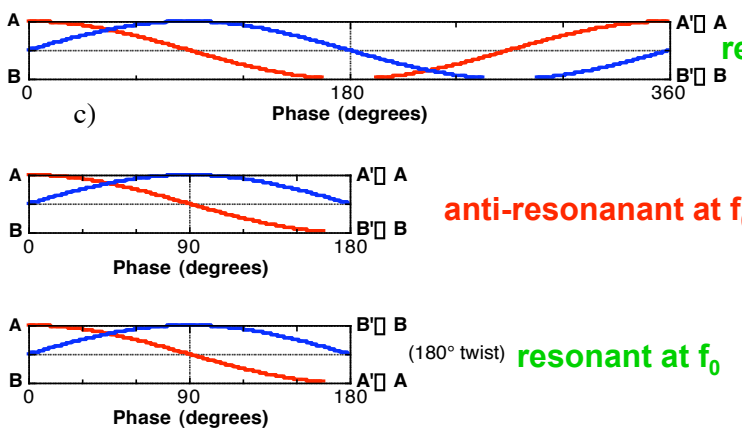
- **Principles of non-orientable surfaces**
  - the concept of “left” and “right” is globally nonsensical
  - the Möbius strip is the prototypical non-orientable surface
  - common description of a Möbius strip is that it has one surface and one edge
- **Combines time-delay phase shift with geometric-deformation phase shift**
  - realize resonance at half the frequency of a “conventional” geometry
  - reduce the size, weight, and volume of a resonator
  - as implemented, a conductor defines the boundary circle and an electric field flux line can be considered to be the surface
- **The unique properties of non-orientable surfaces are compatible with the spatial oscillation of an electromagnetic wave**
  - resonates when the electromagnetic field is phased with the “flipping” between “left handedness” and “right handedness” of a non-orientable surface
  - Möbius resonators are dual-mode and possess intrinsic transmission zeros

Concept and dual-mode properties

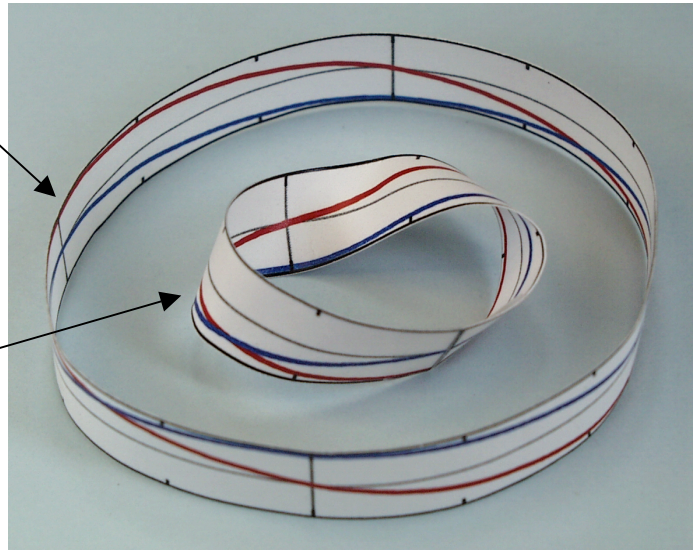
- Sinusoidal and cosinusoidal patterns are plotted on "transmission lines"
- Resonance requires the fields and their derivatives match smoothly when A' → A and B' → B
- When A' → A and B' → B, the 360°- length line (top) and the 180°- length line with twist (bottom) both resonate at the same frequency



resonant at f_0

anti-resonanant at f_0

(180° twist) resonant at f_0



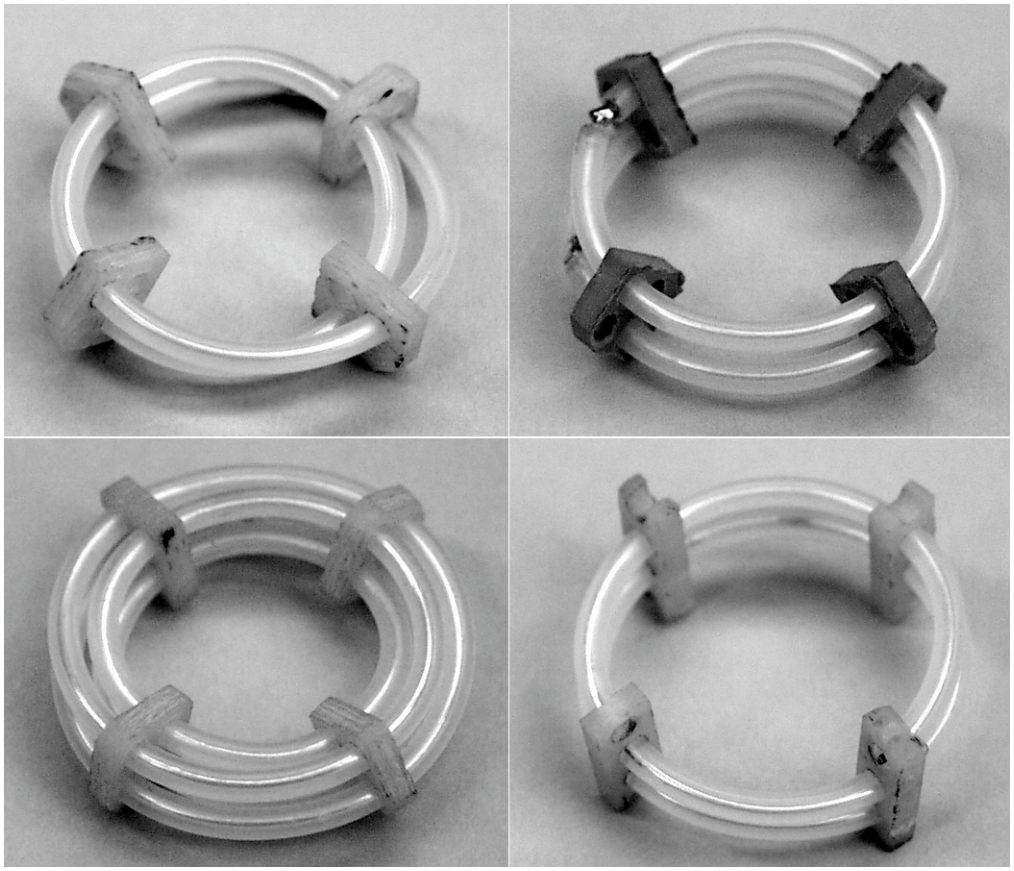
Möbius and conventional resonators

- Wire structures fabricated from 0.085-inch diameter coax from which the outer conductor has been removed
- Several Möbius wire geometries and conventional wire geometries were fabricated with the same mean diameter

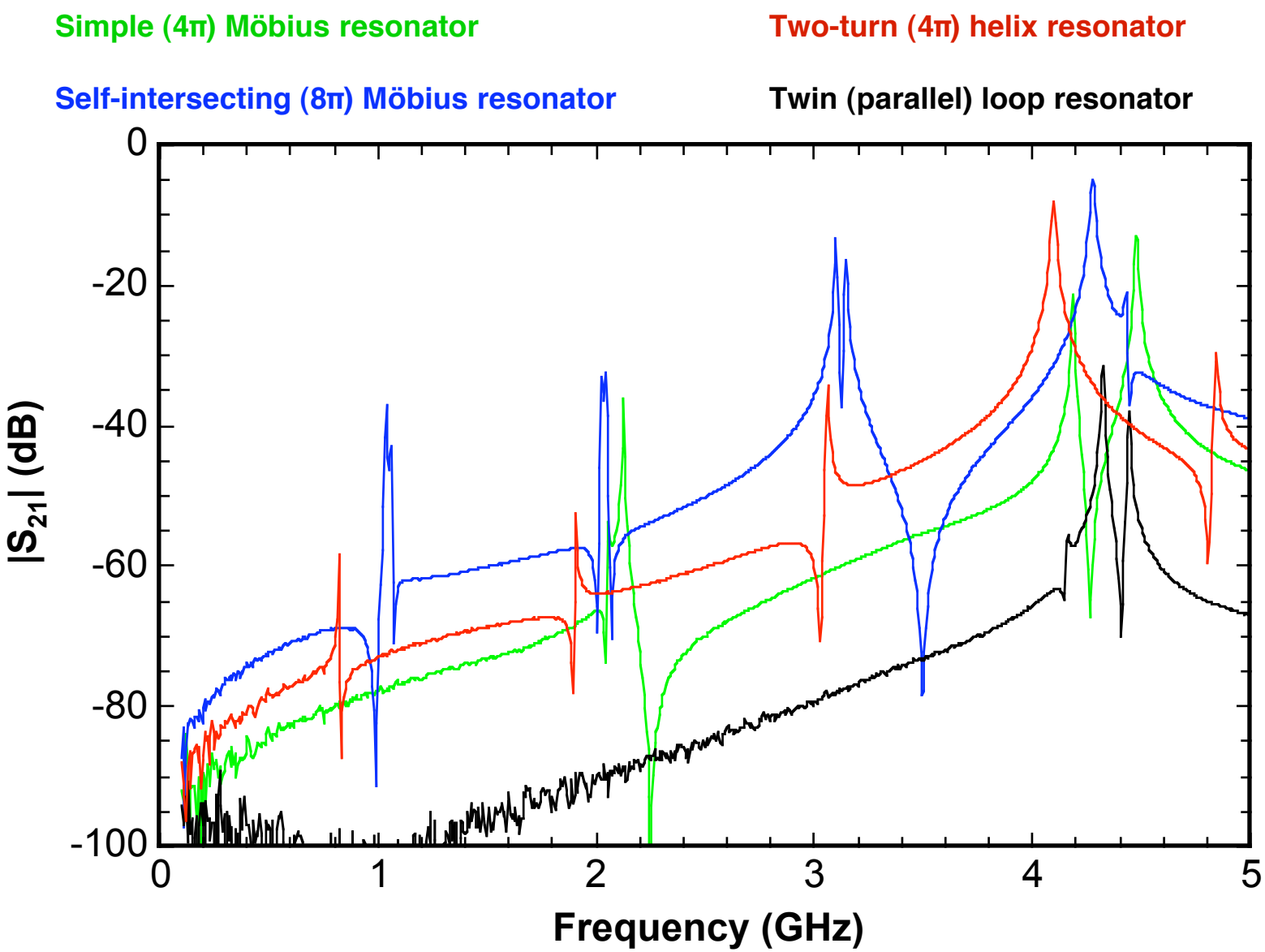
1.90 cm

Simple (4π) Möbius resonator

Twin (parallel) loop resonator



Self-intersecting (8π) Möbius resonator

Two-turn (4π) helix resonator

Measured response of Möbius and conventional resonators