DEPARTMENT OF PHYSICS

Spring 2018 seminar series

NON-RECIPROCAL MILLIMETER-WAVE PROPAGATION THROUGH NANO- AND MICRO-STRUCTURED MAGNETOELASTIC MEMBRANES

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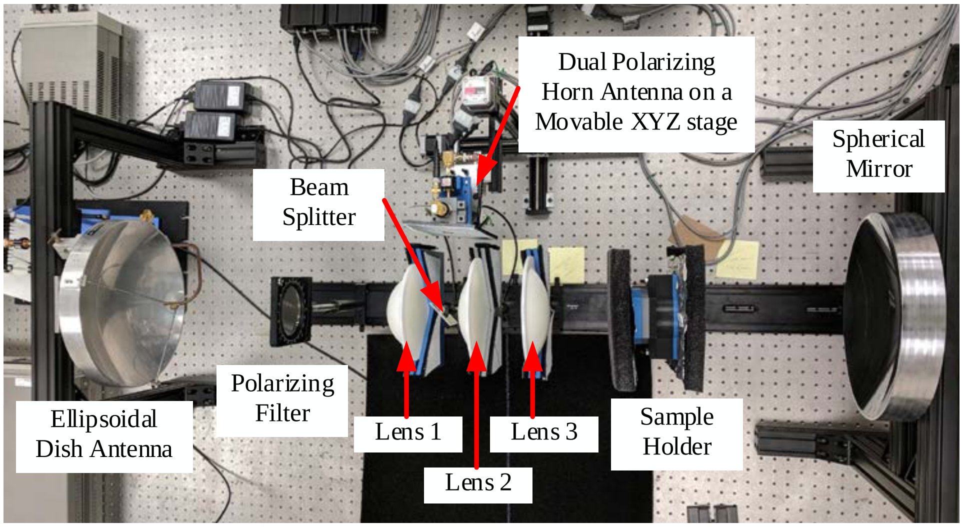
Wednesday, April 18th, 2018
2:00 pm
Ayer Hall 112

Emerging and future wireless technologies (5G and beyond) must accommodate for increasing bandwidth demands while dealing with the issue of spectrum scarcity--the inconvenient fact that traditionally used radio frequencies bands are becoming increasingly congested over time. Sharing the air waves in a coordinated manner by means of cognitive radio will offer incremental relief to this problem, but disruptive advancement will require the use of millimeter waves, which offer orders of magnitude in bandwidth improvement. Due to the strong atmospheric absorption of 60 GHz signals, there has historically not been a compelling motivation to develop consumer electronics that operate near this part of the millimeter-wave spectrum. However, there is currently an opportunity to innovate frequency-agile technologies that will enable low-cost, high-data-rate, line-of-sight communication--for example, short-range wireless backhaul.

In terms of engineering practical components, Faraday rotation is perhaps the most important manifestation of magnetically-broken time-reversal symmetry. It has been used to enable the most common types of non-reciprocal components (e.g. gyrators, isolators, and circulators), which can manipulate the propagation direction of electromagnetic waves. We have recently investigated Faraday rotation imparted on 60 GHz Gaussian beams by magnetized composite membranes consisting of nickel nanowires embedded in polycarbonate and nickel microspheres embedded in silicone rubber. Additionally, we have mounted the silicone magnetoelastic membranes to piezoelectric acoustic resonators and demonstrated control of Faraday rotation angle by means of mechanically modulating the nickel particle density. This form of voltage-controlled magnetism could lead to low-power solutions for frequency-agile, non-reciprocal, millimeter-wave signal processing components.



Photograph of a *one-of-a-kind* quasi-optical apparatus used for characterizing non-reciprocal millimeter-wave propagation through magnetoelastic membranes.