New metamaterial allows transmission gain while retaining negative refraction property

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A new type of active metamaterial that incorporates semiconductor devices into conventional metamaterial structures is demonstrating an ability to have power gain while retaining its negative refraction property, a first in the world of metamaterials research.

"Our simulation and experimental results show that the addition of the battery powered semiconductor diodes not only provided gain, but also maintained the negative index of this kind of metamaterial," said Dr. Hao Xin of the Department of Electrical and Computer Engineering at the University of Arizona. "It is demonstrated, to our knowledge for the first time, that negative index can be obtained with net gain."

Xin says this type of active metamaterial will be very useful not only in designing and achieving new and high performance microwave circuits and antennas, but can also shed light on metamaterial applications at other spectra including optical frequencies.

Documentation of Xin's research, Manuscript LF12974, titled "Active microwave negative-index metamaterial transmission line with gain," by Tao Jiang, Kihun Chang, Li-Ming Si, et al., has been accepted for publication as a letter in Physical Review Letters, a journal of the American Physical Society. Considered one of the foremost physics letters journals, *Physical Review Letters* provides rapid publication of short reports of significant fundamental research in all fields of physics.

Metamaterials are engineered composite materials designed to provide

unique properties that do not exist naturally in materials, such as negative index of refraction, or the ability to bend and redirect light rather than reflect it. Studies of the engineering and processes of these materials may lead to many new phenomena and exciting applications, including advancing the development of near unlimited or "perfect" lenses and new improved types of microwave antennas and circuits for next level wireless communication and sensing.

Dissipated loss has been a major limitation to these applications becoming reality. Xin notes that the results of this research demonstrate that loss in metamaterial can be compensated, an important step towards practical experimental metamaterial with gain in the microwave domain. These data may also shed light on optical gain systems, Xin said.

Provided by University of Arizona