Stars Locations are Uncertain

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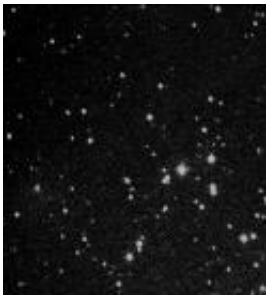

Whether viewed dimly through the haze and lights of a city or in all their glory in a pristine wilderness, the stars that surround the Earth are magnificent, and one day Earthlings will travel to some of the new planets that astronomers are locating. However, **the stars we see are not necessarily where we think they are**, according to an international research team.

"We know that the light from distant stars takes a very long time to reach the Earth," says Dr. Akhlesh Lakhtakia, distinguished professor of engineering science and mechanics, Penn State. "But, taking into account the distance a star will have moved while that light travels, we still may not be able to accurately locate the star.Ó

Negative phase velocity media or materials with negative refractive index may be responsible for this locational uncertainty. Recently, materials researchers at the University of California San Diego, working

with micro and nano materials, developed a metamaterial that had a negative refractive index for microwaves, proving that negative phase materials could exist at least in the microwave part of the electromagnetic spectrum. Their requirements for this material were that both the relative permittivity, a measure of the charge separation in a material, and the relative permeability, a measure of how electrons loop in materials, of a substance must be less than zero.

While the implications for negative phase velocity media in the nano world are the creation of a perfect lens, a lens with no distortion with applications for optical transmission devices, CDs, DVDs, microwave systems, etc., in the universe at large, these media can disguise the location of a star, according to the researchers.

A material with negative index of refraction transmits light or other wave energy differently than one with positive index of refraction. In all natural materials, when an energy beam Ð light, radar, microwave Ð passes through water or glass or some other material, the beam is displaced in the same direction. The amount of displacement depends upon how much the material slows the speed of the beam. In negative phase velocity media, the displacement is in the opposite direction.

Lakhtakia and Tom. G. Mackay, lecturer in Mathematics, University of Edinburgh decided to look at why the permittivity and permeability had to be less than zero. They found that one or both permeability and permittivity could be less than zero and negative phase velocity would occur. They then found that both could be greater than zero and a negative index of refraction would occur but only when special relativity came into play.

The researchers looked at transmission through space, where high velocities are common.

"First I did the derivations with the observer moving and the energy source stationary," says Lakhtakia. " Then Mackay did the derivations with the observer stationary and the light source moving."

What they found was that it depends on the state of the observer whether any particular media at any time has negative or positive index of refraction. The relative velocity of the observer changes the index of any material.

"Light coming off a stellar object passes through many different regions of space filled with different media and is affected by different gravitational fields," says Lakhtakia. "When we finally see it, we cannot really know where it originated."

While this may be of no consequence today, Lakhtakia believes it has important implications for when space travel is common. Because this is a direction dependent effect, it will change the telemetry of objects and spacecraft.

"The business of space navigation and interpreting star maps could be a lot more complicated than we now think it is," says Lakhtakia. "Imagine mining of extrasolar asteroids. We might not want to send humans to do the mining, but robots would have to know where the asteroid is and where on its surface to mine when it left our solar system."

Calculations would need to be made from Earth on an asteroid that might not be where we visually see it. The effects of negative phase velocity media would need to be taken into consideration.

Another problem would be navigating from somewhere far away from the Earth in a space ship using information gathered from the Earth. Depending on the velocity of the spacecraft and the object aimed for, negative phase velocity media between the spacecraft and the destination

would also need to be considered.

Source: Penn State