



4 April, 2012

**Programming Matter:
Smart Surfaces, Molecular Machines and Invisibility Cloaks**

Introduction:

Everything that we can see, small, taste and touch is made of matter. For the first ten thousand years of human development, we crudely shaped matter (like metal and wood) into forms that we could use. In the last two hundred years, humanity has learned to manipulate matter to create exotic substances that could not be found in nature, but continued to mold those substances into shape using macroscopic tools. Now, scientists are programming matter at the molecular level to make shapes too small to see with the naked eye in order to create machines that carry drugs into cells, surfaces that can change their properties in response to temperature, or cloaks that can bend light around them, masking the object underneath.

Speakers:



Lauren Zarzar is a fourth year chemistry graduate student. In lab, she explores an interesting class of "smart", responsive materials called hydrogels. Hydrogels are already being used commercially in a wide variety of products, and today, she will explain what hydrogels are, what makes them unique materials, and how they are currently being used in scientific research as pseudo "muscles" to move around objects on very small scales.



Nicholas Schade is a third year graduate student in the Physics program, studying how to program matter to self-assemble to make so-called "meta materials" which interact with light in unexpected but useful ways. Today, Nick will explain how this type of research will allow us to make devices like invisibility cloaks and superlenses, as well as the current roadblocks to these potentially amazing materials.



Adam Marblestone is a third year graduate student in the Biophysics department, studying molecular engineering and nanotechnology. Most people think of DNA as the way life encodes information, but Adam will explain how technologists are leveraging this informational properties of DNA to build nano-structures. Using computer aided design software, we can now engineer self-assembly reactions in which hundreds of components self-organize to form complex three-dimensional structures and machines, with potential applications to targeted drug delivery.

Glossary

Microscale: Things existing on the order of one micrometer, or one-Millionth of a meter (the thickness of this piece of paper is about 100 micrometers)

Nanoscale: Things existing on the order of one nanometer, or one-Billionth of a meter (about the width of a single molecule of the sugar glucose)

Actuate: To set into motion

Polymer: A substance that has a molecular structure built up from a large number of similar units bonded together.

Hydrogel: A crosslinked polymer that swells in water

Matter: The substance or substances from which all physical objects (solid, liquid or gas) is made from

Electromagnetic Wave: the way that electromagnetic radiation (light) moves through a medium. With our eyes, we can only see a very narrow slice of the **electromagnetic spectrum**, which contains everything from radio waves to x-rays and gamma rays.

Wavelength: The distance between two crests on the wave (this is in turn related to the amount of energy in the wave). High-energy waves like X-rays have very small wavelengths (one billionth of a meter). Very low-energy waves like radio waves can be 1-10 meters long.

Visible light: Light that we can see with our eyes is a very small part of the electromagnetic spectrum, consisting of waves between ~400 nanometers (billionths of a meter) which is violet light, to ~700 nanometers which is red light

Absorption: When the energy from light is absorbed by a material and is not allowed to pass through or bounced back.

Reflection: When the energy from light is bounced back towards its source

Refraction: When a material changes the path of a ray of light

Transparency: the physical property of allowing light to pass through a material

Meta-material: a synthetic substance designed so that it interacts with waves differently than natural materials

Self-assembly: any process in which building blocks spontaneously form an ordered arrangement or structure by themselves

Tetrahedron: from "tetra," meaning "four," a tetrahedron is a pyramid with a triangular base. It consists of four triangular sides.

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