

## **DNA as a molecular photonics device**

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### Overview of Research<sup>1</sup>

While microchips found in everyday electronics have gradually decreased in size until they are now smaller than the point of a sharpened pencil, our group works on research that could one day produce semiconductors that are a million times smaller. A molecule of a material is the smallest particle capable of retaining the physical property of the material, such as the ability to conduct charge. Some molecules possess surprising physical properties that one would not expect. We believe that the DNA molecule is capable of functioning as a semiconductor. Indeed, DNA molecules are perfect nanomachines. Thus the building block of life may become the building block of machines.

Our lab's research into DNA photonics represents collaboration with Argonne National Laboratory, Northwestern University and Boston College, and is sponsored by the National Science Foundation. Our partners have been putting together structures called DNA hairpins, which is a relatively new thing in terms of being able to construct in a laboratory. A DNA hairpin is a single strand of DNA that is bent over like a bobby pin, with several DNA base pairs matched up on each side of the loop. Instead of studying a long strand of naturally occurring DNA that contains thousands of paired bases, scientists prefer to study electron movement in DNA hairpins, where the properties of the DNA are controlled by the deliberate choice of the base pairs contained in it. A small DNA hairpin still offers up everything about its physics, chemistry and biology. Instead of photo-exciting DNA by laser, perhaps one day we will be able to control photo excitation by the sun. Photo excitation by solar energy would permit us to separate a charge and do something with it — that's how a solar cell is supposed to work. The research has implications for bioengineering, medicine and physical chemistry as well as other areas. For instance, DNA molecules may one day be integral in producing electricity more efficiently and less expensively than current silicon solar panels. The way a charge moves through a DNA sequence may one day be instrumental in identifying genetic disorders, genetic damage or viral infections. Many people are looking for the perfect machine, but it literally may be right in the palm of our hands. The art is how to extract the information that we need to know.

### Research Objectives:

The main goal of the present project is to address the question whether DNA photoexcitation is shared between many base pairs or localized within the single base. Other group members are performing calculations of DNA interaction with light and environment including water and salt. The objectives of this research are to use this data and experimental information to characterize DNA excited state for different base sequences. The Matlab software will be used.

### Prerequisites or Experience:

The students suppose to obtain almost all necessary knowledge during training. It is desirable that the students have taken two semesters of general chemistry and calculus. A GPA of 3.0 or higher is preferred.

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<sup>1</sup>The Tulane New Wave Article "The building block of machines", by K. Hobgood and F. Simon dedicated to our group work was extensively quoted when describing the research (see [http://tulane.edu/news/newwave/012909\\_nanotechnology.cfm](http://tulane.edu/news/newwave/012909_nanotechnology.cfm), 2009 copyright by Tulane University. All rights reserved).