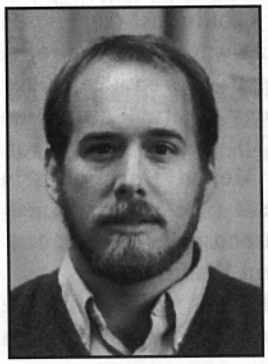
UMR Researcher's Work May Lead to Improved Photocopiers

A University of Missouri-Rolla professor's research into the electrical properties of polymeric materials may one day lead to improved photocopying machines.



Paul Parris

Dr. **Paul Parris,** associate professor of physics at UMR, received a three-year, $150,000 grant from the National Science Foundation's Division of Materials Research to conduct the study, "Theory of Charge Transport in Molecularly Doped Solids."

Parris hopes to learn more about how the materials that form the basis for the photocopying process behave.

"There are many unusual characteristics associated with conduction in these materials that have for years defied a simple microscopic explanation," Parris says. "Their ability to conduct charge exponentially increases with the square root of the electric field applied to them. I want to learn why it rises and how this rise is related to molecular properties of the material."

It was another American physicist, **Chester F. Carlson,** who developed xerography, a way to make copies using dry powder, electric charge and light in 1938. Nearly 60 years later, Parris is creating computer models that will predict the characteristics of photoconduction in disordered polymeric materials.

The polymer films used in copying machines are basically insulating plastics that have been doped with organic molecules, allowing them to conduct charge under illumination.

"The goal is to develop a theoretical model that will predict the molecules' conductivity," Parris says. "We will then compare our results with actual experiments."

Parris may already be well on his way to unlocking the process' secrets. While working with scientists at the University of New Mexico during a recent research leave, Parris discovered "a simple way in which known microscopic properties of these materials can offer an explanation for some of this unusual behavior," he says. "The NSF is providing funding to develop these ideas to the point where they can form the basis for synthesizing new materials to use in xerographic photoreceptors — in other words, to develop new, better materials for use in photocopying machines."

Beyond understanding what happens on a molecular level during the photocopying process, Parris hopes to understand how his findings affect other electronic and photoluminescent devices made from organic materials, such as polyphenylene vinylene. This research could one day lead to improved non-impact printing techniques and flat panel computer displays.

UMR Physics Undergrad Co-authors Paper for Prestigious Physics Journal

The phrase "publish or perish" is often used to describe the competitive world of academia, where it's never too early to start making a name for yourself. That's why undergraduate physics students at the University of Missouri-Rolla, like **Keith Winkler,** are encouraged to get a head-start on the competition.

Keith Winkler

Winkler, a junior from St. Louis, co-authored a paper that recently appeared in *Physical Review Letters,* a publication UMR Curators' Professor of Physics **Don Madison** describes as "the most prestigious journal in the world dedicated to reporting advances in physics research that warrant rapid circulation."

The November publication of the paper represented a major accomplishment for a 21-year-old student. "It's thrilling to see my name next to some of the biggest names in the field," says Winkler.

Madison, who advises a group of four undergraduate physicists at UMR, thinks it's important to introduce students to meaningful research early in their careers. "We do an outstanding job of getting our undergraduates involved in research projects," Madison says. "This is not common at most universities -- where research-intensive study is usually reserved for graduate students."

The latest success story came about through a joint effort with researchers at Griffith University in Brisbane, Australia. The Australian physicists conducted the atomic experiments and Winkler performed all the theoretical calculations associated with their findings. The results -- which described what happens when an isolated sodium atom simultaneously encounters a laser beam and a beam of electrons -- were deemed important enough to be of interest to the global physics community and were subsequently published in Physical Review Letters.

Winkler and Madison, in conjunction with a group from Flinders University of South Australia, are currently finishing work on another project. This research effort is focused on examining the physical effects that can be learned when positrons interact with atoms. According to Madison, it is possible to discover new physics from anti-particles like positrons that could never be learned from normal particles like electrons. The group has just submitted their findings for publication. Winkler is the lead author of this paper -- an accomplishment that Madison describes as very unusual for an undergraduate.

Madison gets annual funding from the National Science Foundation to promote undergraduate physics research. Last year, two of the five winners of an American Physical Society contest for the best research among undergraduates studying atomic, molecular and optical physics in North America were UMR students. **Dan Chitwood,** a senior from St. Louis, and **Chris Maloney,** a senior from Newburgh, IN, were both invited to speak at the society's annual meeting in Santa Fe, NM. Maloney has been named a winner for the second year in a row and will speak at the society's meeting this March in Atlanta, GA.