ABSTRACTS OF REU FINAL REPORTS
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Adviser in (parenthesis)

Jeff Durst, "*Effects of Shadowing on 2-D Polycrystalline Growth*," (Jacques Amar)

The effects of shadowing in 2-D thin film growth were studied using a sputter deposition model. Both cosine and uniform angular distributions were studied. Also studied were the effects of an interfacet diffusion barrier. We find $n = 1/3$ and $\beta = 1$, where n is the mound coarsening exponent and β is the growth exponent, in the case of a cosine distribution with diffusion barrier, and $n = \beta = 1$ in all other cases. We find the facet length coarsening exponent $\delta = 0.8$ for uniform angular distributions. In the case of cosine distribution without diffusion barrier $\delta = 0.8$. Moreover, we find a power law distribution of side lengths of mounds in both cosine and uniform angular distributions when a diffusion barrier is absent. Plotting a scaled graph of $(N)(S_{av})/N_T$ vs. s/S_{av} where N is the number of sides, S_{av} is the average side length, N_T is the total number of sides, and s is side length. F or a uniform distributions, the exponent $\tau = 0.71$. For a cosine
distribution, $\tau = 0.44$. For a uniform distribution both with and without a diffusion barrier as well as a cosine distribution without barrier we find the surface roughening exponent $\alpha = 1.0$. In the case of cosine distribution with diffusion barrier, anomalous scaling of side lengths was found yielding $\alpha = 0.88$. More complex models in three dimensions, especially the cosine-barrier case, could provide a very physical model of experimental sputter deposition thin film growths.

Aaron Garcia, "*Low Energy Proton Impact Disassociation of Acetylene Molecules*," (Song Cheng)

Electrostatic lens was designed via Simion 7 to decrease the kinetic energy of the incident ions from l5keV to 1.5 keV. Total cross sections for single electron capture, single ionization, double ionization, and electron capture plus ionization have been theoretically determined for a specific collision of protons at a specific energy of 1.5 keV with C_2H_2. Recoil time of flights were theoretically obtained for H^+, CH^+, and CH_2^+ fragmentations. In addition. a temporal distribution was obtained through a simulated time of flight spectrum.

Levi Gorrell, "*Temperature Dependence of Electroluminescence with CdTe Solar Cells*," (Alvin Compaan)

In order for CdTe to become a contender in the solar cell market of the future it is imperative that more methods of understanding the properties of cells be produced. Of course when results of experiments don't fit the expected results then it becomes necessary to understand why the behavior is so different. In CdTe solar cells it is important to learn why the behavior of the Electroluminescence of the cells at varying temperatures is different than expected and what causes these differences in order to further our understanding of the cells.

Nicholas Harmon, "*Elastic Electron Scattering for Closed-shell Atoms*," (Constantine Theodosiou)

Differential cross sections of Be, Mg, Ca, Zn, Cd, and Hg were calculated by our program relativistically and non-relativistically. Total cross sections, momentum transfer cross sections, and the Sherman functions were also calculated. The computational results agreed well with the available experimental data on these closed-shell atoms.

Melissa Haugen, "*Raman Scattering in Thin Films*," (Alvin Compaan)

Solar power is quickly growing as an alternative source of energy. This safe, clean, durable technology is making its name as a contender to supply our future energy needs. There are several groups currently working to make solar power both cheap and efficient. They employ many techniques to characterize and study which procedures and materials make the best cells. Often, properties of certain materials provide vital information as to the inner workings of such cells. Physical as well as optical properties, such as Raman scattering, may be very benificial in the study of these materials.

Andy Hill, "*Simulations of Epitaxial Growth with Shadowing in Three Dimensions*," (Jacques Amar)

Compared to simulations done in the past, relatively little attention has been given to models which include shadowing and diffusion. These cases have been for the most part ignored because they are harder to simulate than less realistic, easier to program models simulating vertical deposition in which particles do not move around once they land on the model. While studying the more realistic case of ballistic deposition with shadowing and diffusion, values of $\beta = 1$ and $n = 1$ were found when a uniform distribution was used, indicating an unstable system. Using a cosine distribution, values of $\beta = 1$ and $n = 0.70$ were discovered.

Chandra Jacobs, "*Enhancement of the Control System in Ritter Observatory*," (Nancy Morrison)

This is a very abstract tale of Noah and Miranda, two components of the computer control system in Ritter Observatory at the University of Toledo. They are separated by an umbilical cord-like optical cable that allows Noah, the big strapping CPU on wheels up in the dome to communicate with Miranda, a computer sitting in the fifth floor Ritter control room. Although spoon-fed tender loving care at Ritter's infamous one-meter (40 inch) reflector telescope since a very young, impressionable age, they were unfortunately unable to fully communicate with each other until now -- that is where I come in. I modified Noah's existing telescope controlling program to allow a string containing the telescope's coordinates (right ascension, declination, local mean sidereal time, and hour angle) to pass to Miranda via the half-duplex fiber optic cable. Mission accomplished, and now when one observes in the middle of the night at Ritter Observatory, one does not have to make the desolate journey from the control room, up the flight of steps to the telescope, in order to see where in the sky the telescope is pointed nearly as often.

Marleen Martinez, "*The Abundance of CH^+ in the Vicinity of the Pleiades*," (Steven Federman)

Detection of particular molecules in interstellar space is the beginning of the journey to unlock the mysteries of interstellar chemistry. Using spectroscopy of 20 Pleiades members has provided the foundation for analysis of molecules and gas clouds that are very near to the Pleiades. By analyzing these spectra using IRAF , the abundance and velocity of each molecule reveal interesting trends. For example, filamentary structure is seen in maps of C^+, CH, and Ca II velocity components. These maps will be used to study the relationship between these species.

Jackie Must, "*Clumpy Dust in Reflection Nebulae*," (Adolf Witt)

By using Hubble's equation, $\log \alpha = !0.2m + K$, and data from nebulae catalogues and star catalogues, graphs and histograms were made as a reference basis. From the graphs of the observed data, two questions were asked: If one wants to use the Rubble equation to determine the optical properties of reflection nebulae, how do the physical characteristics such as viewing direction, optical depth, and albedo

of the dust grains affect this? How well can the albedos of the dust grains be determined from the observational data? Sixty computer nebulae models were analyzed and compared to the observed data in order to answer these questions. This is the first of many sets of models to be analyzed in order to answer these questions. So far it was found that our models need to be modified in order to take into account dust limited nebulae. It was also found that a good reference to use to determine the albedo of dust in reflection nebulae might be to use the log of the nebular flux plotted against the log of the radius of reflection nebulae.

Rachelle Ramer, "*Enhancement of wavefunctions for multi-electron atoms*," (David Ellis)

Theoretical physics tries to, among other things, model the world around us. One important model to have is the energies of electron orbitals. Although it is possible to find these energies experimentally, it is far simpler to find them through calculation. Of the several models used in the past, the one most used currently is Multi-Configuration Hartree-Fock. When a large number of configurations is used, MCHF provides a good approximation. However, there is an obvious problem. MCHF fails to consider electron correlation when the distance between electrons is relatively small. This can most clearly be seen by MCHF's failure to satisfy Kato's Theorem for the cusp in electron distribution functions at coalescence. For this paper a new wavefunction, Ψ', will be used, with $\Psi' = \Psi + \alpha\phi$ where α is a constant, Ψ is the MCHF wavefunction, and ϕ is an added correlation term. If α is adjusted to find the minimum energy in accordance with the variational principle an improved approximation for the energy can be found. The ground states of He and Li were used as test cases, for the reason that the actual energy is known for both cases. Both He and Li enhancements showed improvement over MCHF. For Li ^{2}S, the difference between the MCHF AS3 energy and the actual energy is -0.04533. Enhancement provides an improvement on MCHF AS3 energy of -0.00139. Clearly, some improvement is offered by enhancement. More configurations for various elements must be run, however, before definite conclusions can be drawn.

Jonathan Skuza, "*Energy Loss in Ion-Atom Collisions of H^-/He*," (Thomas Kvale)

An electrostatic lens system is needed to focus a parallel or almost parallel ion beam at a specific point. The beam must be focused at the entrance to a hemispherical energy analyzer, so that data can taken. The lens system was designed going off of a previous design that had some complications. The design was significantly modified and tested, so that the lens system can be implemented into the University of Toledo's Positive/Negative Ion Energy Loss Spectrometer (UT-P/NIELS).

Chris Verzella, "*Band Gap Photoluminescence Decay of CdTe Photovoltaic Cells*," (Alvin Compaan)

What is the motivation behind studying junction photoluminescence decay for CdTe solar cells? Photoluminescence decay had been observed in GaAs, GaN, Porous Silicon, and Chalcogenide glasses (As2Te3, etc.) however in each case it was attributed to properties specific to the material it was observed in. Earlier studies at The University of Toledo (UT) have shown the existence of photoluminescence decay in CdTe solar cells however the phenomenon has not been considerably studied. The goal of this project was to obtain photoluminescence decay data from various conditions, examine the data for trends, and attempt to fit a theoretical model non-specific to CdTe to the acquired data. All above objectives where obtained to a certain degree.