

PHYSICS  
ARTS AND SCIENCES

SUMMER RESEARCH OPPORTUNITIES FOR UNDERGRADUATE WOMEN

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PROJECT TITLE: Analysis of Bose Condensate Dark Matter

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**Project Description**

## Analysis of Bose Condensate Dark Matter

The nature of dark matter, which constitutes 80% of the observed matter in the universe, is yet to be understood. The amount of mass contained in galaxies is measured by studying the motion of stars about their centers. Newton's equations of motion indicate that once a star is beyond the edge of a galaxy the square of its velocity is directly proportional to the mass contained inside its orbit and inversely proportional to its distance to the galactic center. Observations indicate that in spiral galaxies the orbital velocity of stars moving well beyond the visible region of the galaxy remains roughly constant with radial distance, indicating that there is some invisible form of matter extending beyond the visible edge. There is evidence that the actual mass contained in some galaxies could be even as large as ten times the visible mass.

What comprises this dark matter is still a great puzzle and determining its identity is one of the most important challenges facing modern astrophysics. It has been hypothesized that certain types of elementary particles termed scalar particles, which carry no intrinsic angular momentum, could form aggregates and be the main constituent of dark matter. Scalar particles satisfy Bose statistics. Namely any number of identical particles can occupy the same quantum mechanical state at low temperatures. This property enables them to congregate together and form large aggregates, termed Bose Einstein Condensates (BECs). Such condensates could in principle form structures as large as known astrophysical objects like asteroids, stars, planets or whole galaxies. The WISE student will be involved in studying the properties of Bose condensates of astrophysical size to see if it is consistent to assume that such objects form the major component of dark matter.