

SIENA COLLEGE

1.00 CREDIT INDEPENDENT STUDY PROPOSAL

———— Particle Physics ————
Exploring Alternate
Interpretations of the Pentaquark
Candidate Observed by LHCb

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1 Proposal

1.1 Rationale for Conducting an Independent Study

I am proposing to engage in this Independent Study because I would like to learn the basics of particle physics as well as gain more experience with Python programming. In this Independent Study, I will strengthen my Python programming and critical thinking skills. This research experience will prepare me for future course work and grad school, if I choose to pursue that path. In the future, I hope to pursue research in Particle Physics and would like to start gaining experience right away.

Python is an essential language in the field of physics and this Independent Study will help me master it. I have learned the basics of Python this year in my CSIS 200 course, and I hope to strengthen these skills so that I am able to code on my own. Additionally, this research experience will introduce me to all of the fundamental particles, including quarks, leptons, and bosons. I will learn what particles are classified under these categories, their properties, and the role they play in the universe.

1.2 Plan of Action

The purpose of this Independent Study is to explore alternate interpretations of the pentaquark observed by LHCb: a particle built of five quarks. Many physicists believe experimental results point toward the discovery of a new particle, known as the pentaquark. However, it is always good to check the work of others. Data from the Department of Energy's Jefferson Lab reveals that the one pentaquark candidate did not hold up to additional experimental scrutiny.

In order to prepare for this analysis, I have read through *Particle Physics: A Graphic Guide* by Tom Whyntie and Oliver Pugh, which has given me an introduction to the field of Particle Physics. In addition, I have started working through particle physics tutorials on the Particle Physics Playground website. These tutorials are available online and use actual data from CERN. In the activities that I have done so far, I have been able to use coding to determine masses of particles that arise from collisions. Using the calculated masses, I have been able to plot histograms to visualize and identify the particles. These introductory activities

have helped me form the fundamental understanding needed to analyze data on my own.

I will conduct the analysis by using a similar approach to the Particle Physics Playground activities. Since one can never be entirely sure of what particles arise from collisions, it is easy to make mistakes in assigning particles. After I come to a conclusion, Dr. Bellis will introduce me to some of his current research in Particle Physics.

1.3 Learning Goals/Objectives

My learning goals for this Independent Study are as follows:

- Does the Pentaquark exist?
- Develop a working knowledge of relativistic kinematics
- Understand why you cannot rely on classical physics to determine the momentum, mass, and velocity of a particle in Particle Physics
- Be able to identify what type of particles arise from collisions, their masses, and what they decay to
- Be able to use Python to calculate the masses and plot histograms of data
- Learn the masses of particles as well as what they commonly decay to

1.4 Expected Project Delivery Date

The expected project delivery date for this Independent Study is May 2016.

1.5 Bibliography/Required Reading

Particle Physics: A Graphic Guide by Tom Whyntie and Oliver Pugh