**Physics graduate program learning objectives 2018**

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**Overall Learning Outcomes**

**Master’s Students**

Demonstrate mastery of subject content knowledge. Students should gain a deep and broad understanding of physics. This involves a grasp of core concepts beyond the level typically seen in undergraduate education, as well as familiarity with the aims and methods of various subfields of physics. This understanding is typically achieved through combination of coursework and seminars, colloquia, and meetings.

**Doctoral Students**

Demonstrate mastery of subject content knowledge. Students should gain a deep and broad understanding of physics. This involves a grasp of core concepts beyond the level typically seen in undergraduate training, as well as familiarity with the aims and methods of various subfields of physics. This understanding is typically achieved through combination of coursework and seminars, colloquia, and meetings.

Conduct independent research and analysis in their disciple and contribute original and substantive work in their field. This is the primary goal of any doctoral program. Its achievement is demonstrated primarily by the writing of doctoral dissertation and the presentation of an oral dissertation defense, both of which are assessed by a faculty committee.

Acquire familiarity with the current literature. To contribute original scientific work, a student must be knowledgeable about the present state of his or her field. This familiarity is typically attained through reading, attending seminars, participating in journal clubs, and other such activities.

Be able to communicate scientific results. The ability to communicate scientific findings, in writing or in presentations, is an important component of a researcher’s portfolio. Norms vary considerably between subfields of Physics, prohibiting blanket statements. Considering publications, for example, few author papers with a doctoral student as the lead author are standard in some subfields. In others, scientific papers can have many hundreds of authors. Similar variety exists for presentations. Nonetheless the development of communication skills is a learning objective for doctoral students in Physics.

**Possible Learning Outcomes for Doctoral Students**

There are as many paths to a Ph.D. as there are Ph.D. students. Unlike an undergraduate degree, or even a Master’s degree, which can typically be completed through a standard program of coursework, a Ph.D. necessarily involves a unique, new contribution to human knowledge. Especially in a field like Physics, there is an enormous diversity of methods and procedures across sub-fields. Therefore, it is futile and unproductive to attempt to describe specific, universal learning goals beyond the broad goal of understanding Physics stated above.

We provide here examples of finer scale learning goals that can apply to *some* PhD students, stressing that it is not, nor can it be, a set that spans all students, dissertations, and degrees.

Proficiency in data analysis. Nearly all subfields of physics involved quantitative analysis of data. Exceptions include some purely theoretical studies, for example aiming for the invention of analytic mathematical treatments of physical problems. Where relevant, and objective of our Ph.D. program is facility with mathematical methods for data analysis, as well as presentation methods.

Proficiency in experimental design. Many studies in physics involve the design and execution of experiments. Where relevant, and objective of our Ph.D. program is the ability to design experiments, considering relevant issues of resolution, sample size, sources of noise, laboratory safety, etc. It should be noted that the scale of design varies enormously between subfields. In parts of high energy physics for example, studies involve thousands of researchers, with large-scale experimental design conducted by many individuals often years before a particular doctoral student’s tenure. In other subfields, experiments are designed by a few researchers, including the doctoral student.