

# International Perspectives on Einsteinian Physics at Upper Secondary School Level

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**Abstract.** This symposium seeks to synthesize research on the teaching and learning of Albert Einstein's special and general theory of relativity at upper secondary school level. The symposium format will allow us to compare and discuss teaching approaches and student learning processes of four relativistic key concepts: Presentations addressing the speed of light, spatial curvature, warped time, and movement in spacetime will demonstrate the vast range of possibilities to introduce upper secondary students to relativistic ideas. The presentations will be followed by a reflective synthesis and a facilitated discussion.

## 1 Introduction

This symposium brings together research conducted in the Netherlands, Czech Republic, Norway, and Australia on the teaching and learning of Einsteinian physics. Building on a symposium held at GIREP 2017 in Dublin (1), the four contributions extend our shared exploration of teaching approaches and student learning processes in the learning domains of special and general relativity.

Even though Einstein's theories of general and special relativity have influenced scientific and technological process for more than one century, physics educators have not fully caught up yet. Relativistic concepts are usually only taught to undergraduate students and consequently, secondary school students routinely learn classical concepts of gravity, space and time. Only recently, the physics education community has started to introduce Einsteinian physics to secondary school curricula (2,3) and to study learner knowledge and experience (4,5).

Conceptual demands in special and general relativity are high and relativistic concepts challenge students and teachers alike. Often, teachers lack the subject and pedagogical expertise to support students' learning (2); students on the other hand struggle with the high level of abstraction and counterintuitive phenomena (5).

## 2 Symposium Overview

Even though the subject is abstract in nature and challenging to teach and learn, we argue that the far-reaching scientific, philosophical and cultural importance of special and general relativity is worth the effort of bringing this novel learning domain to secondary schools. Thus, a goal of this symposium is to provide a coherent set of contributions that encourage a fruitful debate on how to make relativistic concepts more accessible at upper secondary level. The four contributions address these issues from multiple perspectives by centering on four key concepts in special and general relativity. Each presentation will either discuss a novel teaching approach that facilitates learning in Einsteinian physics or present new results on students' conceptual understanding in relativity.

Specifically, the four contributions present

1. a new model of special relativity that illustrates the relationship between the time warps of general and special relativity
2. a meaningful introduction to the light postulate for secondary education students
3. hands-on activities using embedding diagrams to understand spatial curvature
4. results on upper secondary students' understanding of geodesic movement in four-dimensional spacetime.

## 3 Conclusion

In response to the educational challenges that Einsteinian physics presents, this symposium is designed for colleagues interested in the teaching and learning of special and general relativity at secondary school level. The format will provide an opportunity to present new teaching approaches and to discuss results on students' learning processes that will contribute to promote Einsteinian physics as an important part of physics education in the 21<sup>st</sup> century.

## References

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