

# Spring 2018 Colloquium

Department of Physics & Astronomy, TAMU-Commerce

**April 5, Thursday, 4-5 PM in Science Building 127**

(coffee and cookies will be served at 3:50 PM)

**Particle Physics, Quantum Chromodynamics**

**Mass Generation in the Early Universe**

**Dr. Ralf Rapp**

**Texas A&M University - College Station**



Dr. Rapp earned an MS (1993) degree in Physics and a Ph.D. degree (1996) in Physics at the University of Bonn in Germany. His Ph.D. research was on theoretical nuclear and hadron physics. He worked as a post-doc at Research Center Julich, Theo in Germany (1996) and State University of New York (SUNY) at Stony Brook (1996-1999). He continued his research at the SUNY (1999-2002) and also in NORDITA, Copenhagen in Denmark (2002-2003). In 2003, Dr. Rapp began his appointment as an assistant professor at Texas A&M University - College Station. More information can be found at

<https://physics.tamu.edu/people/rrapp/>

## Abstract

In the framework of the Standard Model of elementary particles, the generation of the visible mass in the Universe is closely related to condensation phenomena of originally massless particles and fields. These mechanisms, in turn, are believed to be accompanied by phase transitions associated with the fundamental forces in Nature. In the electroweak phase transition, at about 10 picoseconds after the Big Bang, the recently discovered Higgs Boson condensed, giving rise to large W- and Z-boson masses, but to only small masses of the light up- and down-quarks. On the other hand, in the strong-force transition, at about 10 microseconds after the Big Bang, quark and gluon fields condensed giving rise to the confinement of color charges into hadrons, and generating  $\sim 98\%$  of their mass. We discuss ideas and possible mechanisms underlying these phenomena, and how they can be tested, 14 billion years later, in the laboratory using high-energy collisions of heavy nuclei.