

# KÖLNER Theoretisch- Physikalisches KOLLOQUIUM

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**Universität zu Köln**

**Time: Friday, November 12, 2010, 16.00 h (!) Probevorlesung  
16.35 h Vortrag**

**Speaker: J.Sinova (Texas A&M University)**

## **Echoes of special relativity in condensed matter physics: anomalous Hall effect, spin-helix transistors, and topological thermoelectrics**

Understanding the origin and properties of the different phases of materials and how to control them is at the heart of condensed matter physics. One of the grand challenges of the field is controlling spin-dependent properties without using magnetic fields. To do so, one can resort to the spin-orbit coupling (SOC), which is one of the few echoes of special relativity in condensed-matter physics that connects the spin and charge of the electron. While the weak SOC regime is relatively well understood, the strong SOC regime remains one of the most theoretically challenging at a fundamental level. The study of this regime has given rise to new physical insights in established phenomena, such as the anomalous Hall effect, and new emerging frontier fields, such as topological insulators. We have learned how to exploit SOC to create new paradigms of spin control in complex materials and discover new unexpected links between seemingly disparate ideas as topology, materials science, ferromagnetism, and thermoelectricity. I will broadly describe joint theoretical and experimental efforts on how we use SOC to control transport and other materials properties. I will also show in some detail new theory insights on the anomalous Hall effect,<sup>1,2</sup> the realization of a spin-transistor by exploiting the recent spin-helix state,<sup>3,4</sup> and a new proposal on how to increase thermoelectric efficiency originating from the topological properties of the band structure imparted by the strong SOC in topological insulators.<sup>5</sup>

