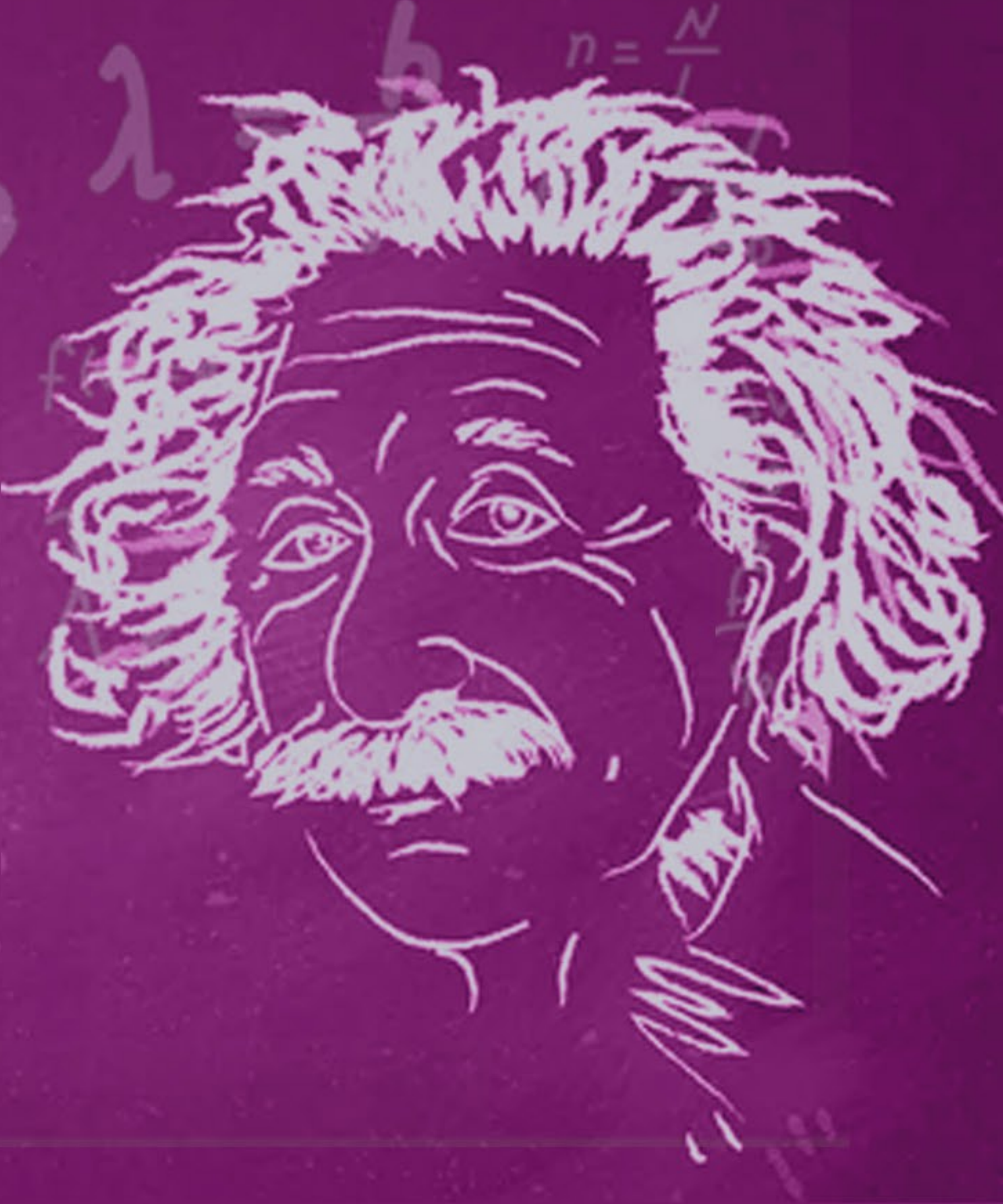




RESEARCH  
INSTITUTE FOR  
FUNDAMENTAL  
SCIENCES

# TÜBİTAK TBAE LECTURES



**M. Cengiz Onbaşı**

*Koç University, Türkiye*

## Applied Quantum Sensing and Quantum Technologies

**2022-2023 Fall**

**Course Catalog:** Review of linear algebra, differential equations, quantum mechanics, operators, and spins. Classical and microelectronic sensing concepts. Signal. Noise. Sensitivity. Noise types. Measurement uncertainty. Sampling. Analog-to-digital conversion. Modern sensing concepts and readout electronics. Discrete quantum states, superposition, entanglement. Quantum measurement protocols (Ramsey, echo and multipulse) and physical implementation examples. Quantum sensing for magnetic fields, electric fields, rotation, temperature and biosensing. Noise spectroscopy, dynamic range and adaptive sampling, ensemble sensing and auxiliary qubit sensors. Example sensing schemes beyond the standard quantum limit using entangled states (GHZ, NOON, squeezed states, W, and other types) to approach or reach the fundamental thermodynamic or Heisenberg uncertainty limits. Quantum sensor design and analysis paper and presentation.

The critical role of young researchers and motivated graduate students in the success of research institutes around the world is very well known. This fact takes an important part among the basic principles of the TÜBİTAK Research Institute for Fundamental Sciences (TBAE). One of the important goals of the Institute is to involve young researchers and students in scientific activities as well as to offer high-level lectures in various fields of fundamental sciences.

**It is difficult to imagine high standards of scientific research without high-level of education. It is also hard to talk about high-level of education without high-level fundamental science background.**

Bugün dünyada temel bilim alanlarında bilgi üretimi inanılmaz boyutlara ulaşırken, bu bilgilerin eğitim sürecine zamanında yansımada doğal olarak sıkıntılar yaşanmaktadır. Bu durum bütün dünyada olduğu gibi bizim ülkemizde de gözlemlenmektedir; Üniversitelerimizin yüksek lisans ve doktora programlarında yeterince ileri düzey dersler açılmamaktadır. Bunun gibi sorunların giderilmesi yönündeki gelişmelere önemli katkılar sağlamak amacıyla, TBAE bünyesinde genç araştırmacılara, son sınıf lisans, yüksek lisans ve doktora öğrencilerine yönelik ileri düzey dönemlik dersler açılacaktır.

**Bio:** Mehmet Cengiz Onbaşı is an assistant professor of Physics and Electrical-Electronics Engineering at Koç University. He is a senior researcher at TÜBİTAK National Metrology Institute Quantum Metrology Lab. His current research areas include spintronic and photonic quantum materials modeling, device fabrication, and testing. His lab specializes in the molecular beam epitaxy and pulsed laser deposition and characterization of new functional 2D materials. His lab also develops spintronic and photonic logic and sensing devices.

Mehmet Cengiz Onbaşı obtained his Bachelor of Engineering degree from Bilkent University Electrical-Electronics Engineering in 2010 and his PhD in Materials Science and Engineering from Massachusetts Institute of Technology in 2015. He published more than 100 peer-reviewed journal or conference papers including Science, Nature Materials and Nature Electronics. His research on quantum materials and devices have been supported by Turkish Academy of Sciences (TUBA-GEBIP), the European Research Council Staring Grant and Proof of Concept grants and by TÜBİTAK. He is a senior member of Optica (formerly Optical Society of America).