



UNIVERSITÀ
DI TRENTO

Dipartimento di
Fisica



PhD Program in Space Science and Technology - SST

Hibernation, Synthetic Torpor, and the Human Factor: From Molecular Mechanisms to Space Exploration

Specific Seminar – Curriculum 4

2026, June 4 28, 4:00 p.m.

Speaker:

Prof. Matteo Cerri - Department of Biomedical and NeuroMotor Sciences, University of Bologna, Italy

Abstract:

Introduction. Hibernation and torpor are physiological strategies adopted by numerous mammalian and avian species to cope with adverse environmental conditions. During torpor, body temperature, metabolism, and energy expenditure drop dramatically, while the organism maintains remarkable protective mechanisms against cold injury, muscle atrophy, bone loss, and oxidative stress. Understanding the molecular and neural underpinnings of these processes opens revolutionary prospects in both medicine and space exploration. The ESA Topical Team on Hibernation and Torpor aims to build a translational framework for applying these insights to human physiology.

Methods. This seminar addresses three interconnected lines of research. The first concerns techniques for inducing synthetic torpor in non-hibernating species: pharmacological, genetic, and neural approaches, including the targeted stimulation of hypothalamic and brainstem neuronal populations, have demonstrated the feasibility of inducing controlled hypometabolic states in rodents and, more recently, in non-human primates. The second line focuses on the clinical and space applications of torpor: reduction of ischaemia-reperfusion injury, neuroprotection, resistance to ionising radiation, and prevention of muscle atrophy and bone demineralisation during long-duration missions. The third line examines evidence suggesting that the capacity to enter a torporlike state may be preserved in our own species. Anecdotal cases, including the survival of mountaineers Lincoln Hall and Beck Weathers in the death zone on Mount Everest, and a reinterpretation of Oliver Sacks's case of "Uncle Toby", offer provocative supporting data. A systematic analysis of 101 documented cases of Spontaneous Periodic Hypothermia (SPH/Shapiro's Syndrome) is also presented; cluster analysis of symptom profiles suggests two distinct subtypes, potentially linked to autonomic nervous system dysfunction.

Main Findings & Outlook for Future. Taken together, the available evidence suggests that some humans may retain an ancestral capacity to enter torpor-like states. Unlocking this capability could open transformative avenues in medicine, including critical care, neuroprotection, and surgery, as well as in space exploration. For long-duration missions, human torpor could substantially reduce spacecraft mass and volume, ease the psychological burden on crew members, and lower consumable requirements. On the biological front, advances in understanding torpor-induced radiation resistance and the molecular mechanisms protecting muscle and bone are already pointing to novel therapeutic targets. Synthetic torpor technologies, now successfully demonstrated in non-hibernating species, represent the bridge between basic biology and clinical or space application. The ESA Topical Team's work aims to chart a scientific roadmap that brings these possibilities meaningfully closer to reality.

Online attendance:

Information on remote participation can be requested by sending an e-mail to dn_sst@unitn.it

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