PhD in Energetics

Research Title: Modeling liquid metals for nuclear applications

Funded by	ENEA, NEMO group @ DENERG

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Context of the research activity	Liquid metals are used in both fission and fusion nuclear systems: as coolants in nuclear fast reactors and as coolant/breeder/multiplier in fusion reactor blankets as well as in advanced divertor solutions for future fusion reactors like the Divertor Tokamak Test (DTT) facility, or the EU DEMO. The development of liquid metal-cooled fast reactors (LMFR) is currently under way within the Generation-IV Program all over the world. At the same time, there is a growing interest for liquid metal solutions to the critical power exhaust problem in a fusion reactor. Both ENEA and Politecnico di Torino have been involved in the past years in various national and international projects in both fields. The assessment and design of LMFR technology requires reliable and accurate computational tools to simulate the core behaviour in operational and accidental situations in a multiphysics environment. In particular, the bypass flow distribution is to be correctly modelled in order to assess the temperature field of the fuel elements encasing and therefore their thermomechanical behaviour. This thermo-fluid-dynamic analysis must be coupled to the neutronics of the reactor core. In the past years the NEMO group of Politecnico di Torino has been developing and testing the multiphysics code FRENETIC for the transient analysis of LMFR, and developing in collaboration with ENEA a first thermodynamic model of a liquid metal pool-type divertor, and applying it to the case of the DTT.

Objectives	The main objectives of the PhD program are the following: • Development of a computational tool for the determination of the thermal field within the fuel element of a LMFR, aimed at the study of thermomechanical effects • Further development, validation and application of the FRENETIC code for the full-core multiphysics simulation of LMFR. • Development of an engineering model, and application to the preliminary design, of a liquid metal divertor for DTT/DEMO.

Skills and competencies for the development of the activity	Background in nuclear engineering; good competence in the modelling of nuclear systems and in the development of multiphysics computational tools