Numerical Modeling of Protein Spreading and brain atrophy in Neurodegeneration

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Abstract: Neurodegenerative diseases significantly impact the global population, affecting millions of individuals worldwide. Some of these diseases, categorized as proteinopathies (for example, Alzheimer's and Parkinson's diseases), are characterized by the accumulation and propagation of toxic proteins (prion-like hypothesis). Protein agglomerations ultimately lead to the degeneration of neurons and brain atrophy. This talk proposes a novel multiphysics coupled model that describes the interplay between toxic protein dynamics and induced tissue atrophy. We discretize the proposed coupled model using advanced discretization schemes that support agglomerated meshes, enabling efficient high-fidelity numerical simulations while maintaining a high-quality representation of brain sulci and internal interfaces. We present realistic simulations based on patient-specific brain geometries reconstructed from magnetic resonance images to predict the development of the neurodegeneration process.

This research is supported by ERC SyG NEMESIS (Grant Agreement 101115663) funded by the European Union.