Training Plan for PhD Student

Project Title: Structure and Dynamics of Heteromeric Amyloid Fibers Involved in Immune Response Studied by Solid-State NMR

Research Focus: Our research group is dedicated to uncovering the molecular details behind various supramolecular assemblies, particularly focusing on the aggregation of proteins during liquid-liquid phase separation and homo- and heteromeric amyloid assembly. We also investigate the role of lipids in these processes using advanced NMR techniques, both in solution and solid-state, complemented by hyperpolarization schemes and computational methods.

Training Components:

1. **Solid-State and Solution NMR:**
   - Intensive training in solid-state NMR techniques, with a strong emphasis on amyloid proteins, including dynamics and interactions with lipids.
   - Training in solution NMR to study protein structures and dynamics in a liquid environment.
   - Specific focus on relaxation experiments of ^15N and ^13C, including DEST and related expeirments.
2. **Computational Methods:**
   - Molecular Dynamics (MD) simulations to model protein dynamics and interactions.
   - Quantum Mechanics (QM) calculations for detailed electronic structure analysis.
3. **Biophysical Characterization Techniques:**
   - Circular Dichroism (CD) for secondary structure analysis of proteins.
   - Fluorescence spectroscopy for studying protein folding and interactions.
   - Thioflavin T (ThT) assays for detecting amyloid fibril formation.
   - Dynamic Light Scattering (DLS) for size distribution and aggregation state analysis of proteins.
4. **Integration and Application:**
   - Use of an integrative approach combining experimental and computational methods to design, understand, and optimize supramolecular assemblies.
   - Application of acquired knowledge to study the role of heteromeric amyloid fibers in immune responses and neurodegenerative diseases.
   - Development of new methodologies, such as “optoNMR,” for controlled, light-triggered protein assembly within the NMR tube.
5. **Scientific Communication and Professional Development:**
   - Training in scientific communication, including oral and written presentation skills.
   - Attendance and participation in national and international conferences such as EUROMAR, ISMAR, and specialized NMR group meetings of the RSEQ.
   - Participation in international NMR schools, such as the Manuel School NMR Summer School and the Winter School on Solid-State NMR.
6. **Mentorship and Collaborative Opportunities:**
   - Weekly meetings with the supervisor and the members of the group to plan experiments and discuss progress.
   - Participation in group meetings to present and discuss scientific advances.

- Opportunities for short stays in international research groups to broaden research experience and foster collaborations.

Goals:
The primary aim of this PhD project is to equip the candidate with the skills necessary to conduct independent research, ensuring a comprehensive and enriching academic experience. The candidate will gain proficiency in advanced NMR techniques, computational methods, and biophysical characterization, preparing them for a future career in academia or industry.

This training plan ensures that the PhD student will receive comprehensive, multidisciplinary training, fostering both scientific and professional development.