Project Title: Study of hydrodynamics theories of active matter

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Project Summary: The proposed project aims to construct more general models of active matter using effective hydrodynamic theories. The research will focus on exploring the properties of random forces responsible for microscopic fluctuations and external velocity fluctuations. The resulting model will be studied initially within the linearized approximation without the presence of interactions, followed by the inclusion of interactions and the application of statistical field theory methods such as the Feynman diagrammatic technique and renormalization group. The project's outcome will have significant implications for the study of active matter in biology, robotics, medicine and various other fields.

EXCELLENCE

Present state of subject: Active matter is a rapidly developing field of research that has drawn considerable attention in recent years due to its potential applications in a variety of scientific fields. The study of active matter involves understanding the collective behavior of self-propelled entities that exhibit non-equilibrium behavior. This research area is still in its early stages and while there already exist some models of describing specific types of active matter systems many questions still remain unanswered. The proposed project seeks to address this gap by constructing more general models of active matter that can be used to explore the fundamental properties of these systems.

Scientific goal: The scientific goals of this project are to develop more general models of active matter that incorporates the effects of random forces and external velocity fluctuations and to study the resulting models using both linearized and non-linear approximations. The project aims to investigate the collective behavior of active matter systems and to identify the key parameters that influence their behavior and to develop a deeper understanding of the role of interactions in active matter. In addition, the project seeks to explore the potential applications of this research in biology, medicine and other fields as well as to become a general starting point for further research of active matter.

Research methodology: The proposed research will use effective hydrodynamic theories to construct more general models of active matter. The models will be studied using both linearized and non-linear approximations, with the latter requiring the use of statistical field theory methods such as the Feynman diagrammatic technique and renormalization group. The project will involve the development of new theoretical tools and the application of existing techniques to the study of active matter. The research will be conducted through a combination of analytical and numerical methods, including simulations and analytical calculations.

IMPACT OF RESEARCH

Enhancing the potential and future career prospects: The proposed project will enhance the applicant's potential and future career prospects by providing training in theoretical physics, especially statistical and fluid mechanics, which are critical for a career in academia or industry. The project will also provide opportunities for the applicant to collaborate with other researchers in the field and to present their work at conferences and workshops. The project's

outcome will contribute to the applicant's research portfolio and increase their visibility within the research community.

Exploitation and dissemination of results: The project results will be disseminated through peer-reviewed publications, conference presentations, and public outreach activities. The project's outcome will have significant implications for the study of active matter in biology and other fields serving as a starting point for research and could potentially lead to new technologies and applications. The project's findings will be of interest to both academic and industrial researchers and could contribute to the development of new materials, devices, and systems.

IMPLEMENTATION

Work plan and tasks: The work plan for this project is divided into five main tasks:

(1) literature review and development of theoretical framework ,

(2) Analysis in the linearized and non-linearized approximation ,

(3) application of statistical field theory methods ,

(4) numerical simulations and data analysis,

(5) dissemination of results.

Task 1 will involve construction of a generalized model through a comprehensive review of the literature and the development of a theoretical framework for the project. Task 2 will be analysis of the constructed model in the linearized approximation without interactions as well as with interactions which directly leads to Task 3, which will involve the application of statistical field theory methods, including the use of Feynman diagrammatic techniques and renormalization group methods to study the interactions. Task 4 will be the analysis of the simulation data and the comparison of the results with experimental data from the literature. This will allow for the refinement of the model and a better understanding of the behavior of active matter systems. Task 5 will involve the dissemination of results through publications and presentations.

Risk management: The main risks associated with this project include technical risks, project management risks, and external risks. Technical risks include the possibility that the theoretical predictions may not be supported by the numerical simulations or that the statistical field theory methods may not be applicable to the problem at hand. Project management risks include the possibility of delays or cost overruns due to unforeseen circumstances such as illness, equipment failure, or changes in project scope. External risks include the possibility of changes in funding levels or regulatory requirements that may affect the project's progress. To mitigate these risks, the applicant will work closely with collaborators in the field, establish clear milestones and deadlines, and maintain regular communication with funding agencies to ensure that the project remains on track. In addition, the applicant will develop contingency plans and alternative strategies to address any unforeseen circumstances that may arise during the project.