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Title:	A Brief Summary of Research Results Supported by Institutional Computing under Project W11_Exoplanet
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A Brief Summary of Research Results Supported by Institutional Computing under Project W11_Exoplanet (PI: Hui Li, hli@lanl.gov)

With the support from the Institutional Computing resources, during the past two years, we have made important progress on understanding the interaction between protoplanets and their surrounding disks:

1) We have developed a new 3D hydrodynamic code that simulates the dynamics of astrophysical accretion disks. We applied this code to understand the dynamics of exo-planets.
2) We studied the influence of disk viscosity of the migration of exo-planets and show that the shock dissipation can fundamentally alter the migration dynamics, resolving a serious challenge to the survivability of these planets.
3) We have also implemented the evolution of dusts in disks. This will allow us to calculate the infrared emissions from the disk and make comparisons between simulations and observations.
4) We have formed new collaborations with Prof. C. Dullemond at MPA-Heidelberg and Dr. Tilman Birnstiel (CfA, Harvard University)

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Publications:

1) Johnson, J.L. & Li, H. ``The First Planets: the Critical Metallicity for Planet Formation", Astrophysical Journal, 751, 81 (2012)

2) Johnson, J.L. & Li, H. ``Formation of the First Planets via Gravitational Instability:
Regulation by the Cosmic Microwave Background", Monthly Notices of Royal Astronomical Society, 431, 972 (2013)

3) Johnson, J.L., Whalen, D.J., Fryer, C.L., Li, H. ``The Growth of the Stellar Seeds of Supermassive Black Holes", Astrophysical Journal, 750, 66 (2012)

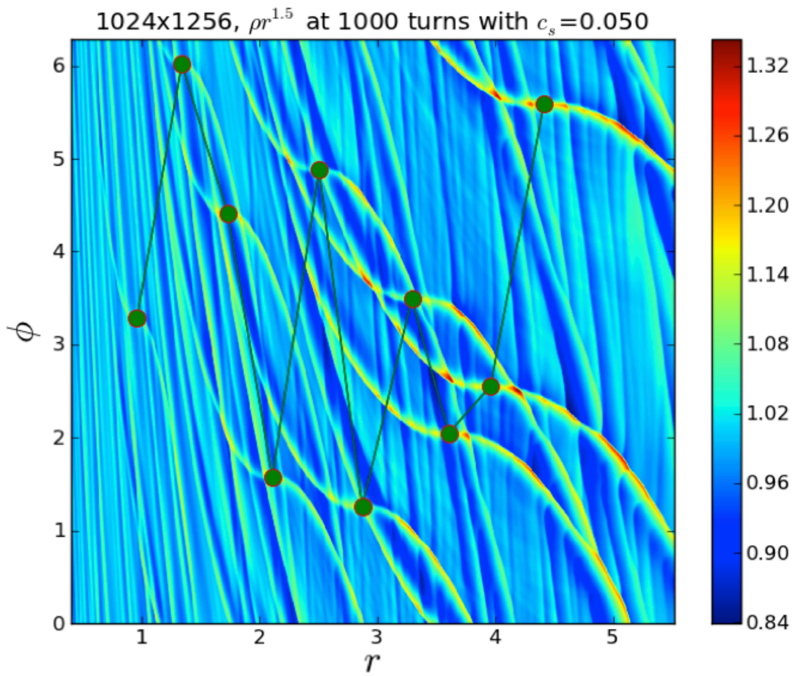
4) Johnson, J.L., Whalen, D.J., Li, H., & Holz, D.E. ``Supermassive Seeds for Supermassive Black Holes", Astrophysical Journal, submitted (2013)

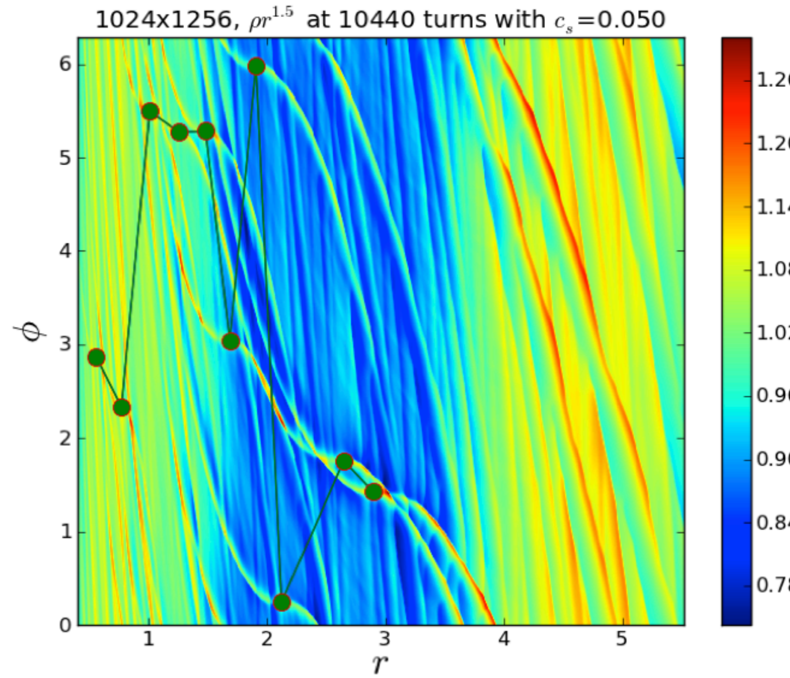
Financial Impact:

1) We won a UC-fee proposal (collaboration between LANL and UCSC) in FY12;

2) We are currently supported by an LDRD/ER on protoplanets, FY12-14;

3) We submitted a proposal to NSF/NASA on protoplanets in FY13





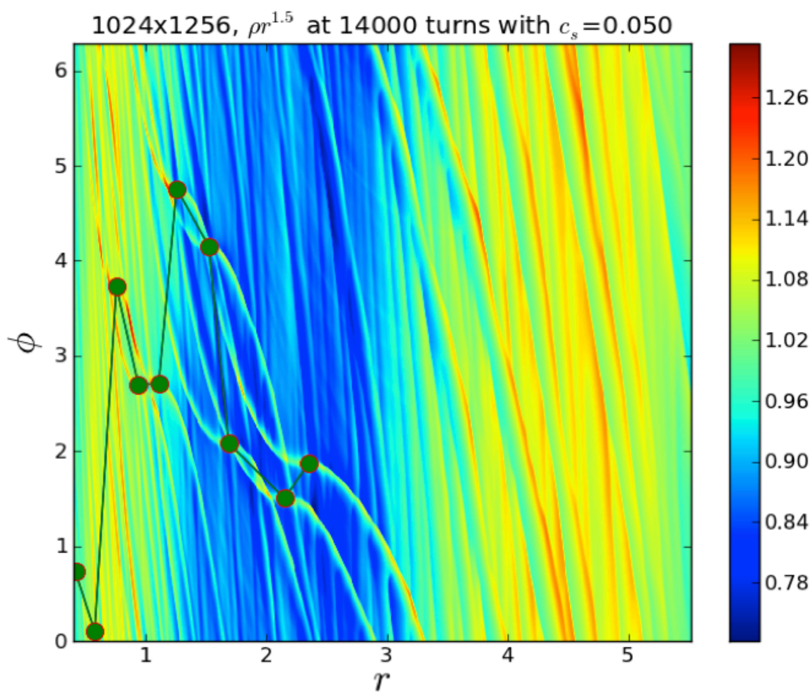


Figure 1: Normalized disk surface density with 10 protoplanetary cores. All cores show relatively quick migration. The disk develops a shallow gap in the mid-region, possibly due to the relatively long time the planets spend in that region. These studies will help us understand how disk can give rise to multiplanets and how these planets interact with each other and how they could survive such interactions.