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Pebble Accretion Mechanism on building the Earth

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Pebble accretion is a model which suggests the accretion of planetary bodies from millimeter size particles in the presence of nebular gas. The application of this theory to the formation of terrestrial planetary embryos leads to new insights about their compositional constraints and growth rates. Two basic building blocks of the terrestrial planet are the silicate chondrules and metal pebbles. In this study, we develop a 2-D mass accretion model for the Earth in the presence of gas drag and Keplerian shear, where we represent the pebbles by their respective Stokes number. We solve for the planetary mass as a function of time using second order Runge-Kutta numerical method. For this study, we choose a headwind velocity of 30 kg/m^2, gas column density of 10^3 kg/m^2 and initial Earth mass of $\sim 10^{-3}$ times the present-day Earth mass. Results show that our accretion model is potentially able to produce an Earth-like solution within the given range of metal aggregates and metal grains combined by ordinary chondrules. Additionally, this mass accretion, being mainly shear dominated, reaches one Earth Mass in 2 My. In future, an interesting extension of our current model would be to consider the metal grains and metal aggregates as separate pebble types because of their unequal relative column densities as well as to include other chondrule types.