Rotations of Planets and Asteroids

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In his 1969 book, Victor Safronov devoted two chapters to the topic of planetary rotation, one on rotation rates and another on obliquities. The chapter on rotation rates was mainly a critical review of the inadequacies of past work, but nonetheless inspired dozens of research papers by various authors who have since made enormous progress in understanding the origin of planetary rotation. I will review these later works in the context of Safronov's earlier critique. The second chapter reported more satisfactory results, showing how the obliquities of planetary spins are likely due to the largest planetesimals colliding with the planet embryos in the accretion process. I was inspired by this work to apply the same formalism to the problem of asteroid rotations, to develop a theoretical model for the collisional evolution of asteroid spins. A feature of this model is the prediction that gravitationally bound objects will have rotation rates that are essentially constant with respect to size, whereas bodies held together by material strength will have mean rotation rates that are inversely proportional to size. This model, first published in 1979, appears to have been confirmed recently with the discovery rotation rates of several asteroids <100 m in diameter which appear to follow this inverse relationship. A striking inference from the recent observations is that material strength is apparently the dominant binding force only for asteroids smaller than ~100 meters in diameter; larger bodies are almost exclusively "rubble piles" held together only by their own self-gravity.