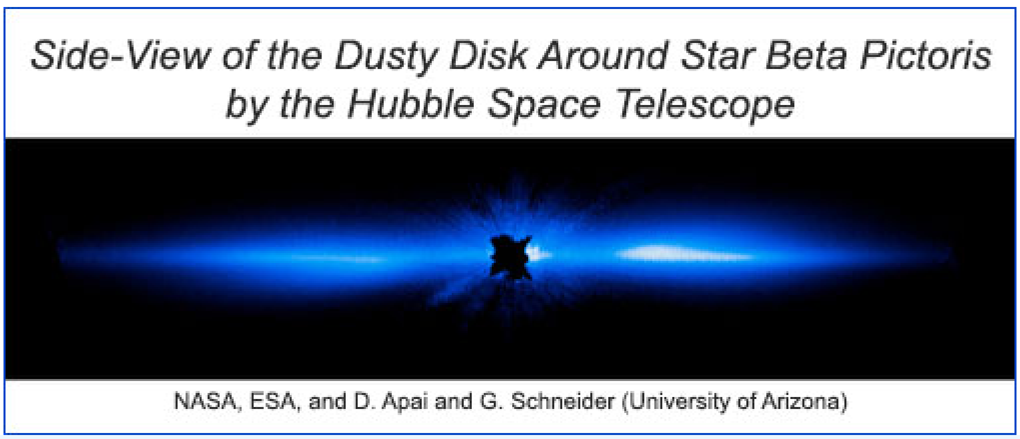
Life Span of the Solar Nebula

PSRD covers many published papers that focus on understanding the conditions and processes of the ***solar nebula***, the disk of gas and dust from which our Solar System formed about 4.567 billion years ago. Researchers are using chemical and isotopic analyses of elements in meteorites, stardust, and comet samples together with dynamical modeling to form hypotheses about the solar nebula's structure, cooling rates, and the migration and ***accretion*** of solid bodies.

But, after the Sun and planets began to form, how long did the solar nebula last before the gas finally dissapated? Theory says that magnetic fields play a part in transferring angular momentum through a gaseous, spinning, ***protoplanetary disk***, thus influencing the disk's structure and evolution. Scientists are using this idea to study the solar nebula's magnetic field by way of measuring the remanent magnetism preserved in meteorites.



We are able to see protoplanetary disks of gas and dust revolving around other stars, similar to the solar nebula from which our own Solar System formed. For example, Beta Pictoris, a 20-million-year-old star that is 63 light-years away from Earth has a protoplanetary disk. This visible-light image obtained with the Hubble Space Telescope Imaging Spectrograph shows the edge-on view of the star's bright disk of gas and dust. Ground-based telescopes have even identified a Jupiter-sized planet in this disk. The star itself is blocked out so that the disk is more easily seen. For additional information, see ***Hubblesite***.

Huapei Wang (MIT and currently at China University of Geosciences, Wuhan Hubei) and colleagues at MIT, Harvard-Smithsonian Center for Astrophysics, National Synchrotron Light Scource-II/Brookhaven National Laboratory, and the Museu Nacional, Rio de Janeiro, Brazil, studied the remanent magnetism of ***basaltic angrite*** meteorites [***Data link*** from the Meteoritical Society]. Angrites are samples of a ***differentiated*** parent body that formed a metallic core.

Measuring the remanent magnetic intensities of ***magnetite*** grains in four (previously well-dated) angrites, Wang and colleagues aimed to determine the strength of the ambient magnetic field present when the molten material crystallized. They discovered that the oldest angrites formed in a near-zero magnetic field (< 0.6 microtelsa) about 3.8 million years after our Solar System began to form. And the authors make the case that the near-zero magnetic field at this time extended throughout the terrestrial planet-forming region. Based on their findings, Wang and coauthors suggest that the solar nebula lasted about 3.8 million years after the formation of the first solids (***CAIs***) in our Solar System.

In contrast, the researchers found that the youngest angrite meteorite in the study cooled in a ~17 microtesla magnetic field about 11 million years after the Solar System began to form (and well after their inferred dispersal time of the solar nebula). They attribute this case to the activation of a dynamo inside the angrite parent body, an idea consistent with models of differentiation, thermal evolution, and convection inside planetesimals.

Analyses of the remanent magnetism in meteorites of known ages are having a big impact in determining the life span of the solar nebula, which in turn helps researchers better understand the timing and mechanisms of planet formation and migration.

See Reference:
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Written by Linda Martel, Hawai'i Institute of Geophysics and Planetology, for ***PSRD***.

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http://www.psrd.hawaii.edu
psrd@higp.hawaii.edu