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The First Day in the Life of a Magnetar

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The plateau phases in the X-ray light curves of gamma-ray burst afterglows are explained by the presence of newly-born millisecond magnetars that are slowing down under the action of the spin-down component of the magnetic dipole radiation torque. The alignment component of this torque affects the angle between the magnetic dipole moment and rotation axis of the star, i.e., the inclination angle. We present, for the first time, the effect of the alignment torque coupled with the spin-down torque on the evolution of a nascent millisecond magnetar in the presence of a corotating plasma by modeling the X-ray afterglow emission of gamma-ray bursts. We find that the rotation and magnetic axis of the magnetar align rapidly during the afterglow emission. We discuss that the magnetic dipole moment may also be decreasing rapidly during the first day of a nascent magnetar which suggests afterglows without an apparent plateau phase may be powered by magnetars. Finally, we show that the braking index of a nascent magnetar varies rapidly due to the alignment torque as well as rapid evolution of the magnetic dipole moment.

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