GAMMA-RAY SPECTRA AND VARIABILITY OF CRAB NEBULA OBSERVED BY BATSE

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Abstract We report results of ~600 days of gamma-ray (30 keV to 1.7 MeV) earth-occultation observations of the Crab Nebula made by the BATSE experiment during the first three phases of the CGRO (Compton Gamma-Ray Observatory) mission between 1991 May 24 (TJD 8400) and 1994 October 2 (TJD 9627). During this period, the time averaged spectra with unprecedented statistics measured in three consecutive 400-day periods, namely, TJD 8400-8800, 8800-9200, and 9200-9600, can be characterized consistently by three broken power-laws with indices of ~2.04-2.06 from 35 keV to ~94-101 keV, ~2.34 from ~94-101 keV to ~650-700 keV, and ~1.7-1.9 from ~650-700 keV to ~1.7 MeV.. Lightcurves with 1-day resolution in six different energy bands, 35-100 keV, 100-200 keV, 200-300 keV, 300-400 keV, 400-700 keV and 700-1000 keV, show that (1) positive flux was detected daily in each energy band on an average of at ~31σ, 20σ, 9.2s, 4.5σ, 2.6σ,, and 1.3σ significance, respectively, and (2) pronounced systematic flux variations were observed in the three lower energy bands from 35 keV to 300 keV, but less in the three high-energy bands from 300 keV to 1 MeV. The χ^2 for fitting a constant value to the 612 daily fluxes in each energy band is 3.3, 2.0, 1.3, 1.1, 1.1 1.0, respectively. We observed variability of the broken power-law spectrum in the 35-300 keV range over time scale of days, confirming previous reports by several investigators. We interpret these results as synchrotron emission produced by the interaction of particles ejected from the pulsar with the field in different dynamical regions of the nebula system observed recently by HST and Chandra.