Crab Nebula Flares: Too much ado about not too much?

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The Crab Nebula Spectrum

Shock acceleration

Flares

De Jaeger
Harding 94
Maximum Shock Acceleration Energy

- The shortest shock acceleration time is that of the Bohm time scale, i.e. $\tau_{\text{acc}} \sim \frac{R}{c} \sim \kappa \left(\frac{\gamma}{B}\right)$ ($\kappa$ is a constant involving $e, c, m_e$).
- During acceleration, electrons suffer also synchrotron losses on a time scale $\tau_{\text{loss}} \sim \frac{\gamma}{(d\gamma/dt)} \sim \lambda \left(\frac{1}{B^2 \gamma}\right)$ ($\lambda$ is also a constant).
- The maximum electron $\gamma$ is obtained when $\tau_{\text{acc}} \sim \tau_{\text{loss}}$ i.e. for $B\gamma^2 \sim \left(\lambda/\kappa\right)$, and the corresponding synchrotron energy will then be $\nu \sim B\gamma^2 \sim \left(\lambda/\kappa\right) \sim 50 \text{ MeV}$ dependent only on $e, c, h, m_e$.
- The existence of photons at energies about 10 times larger has cause sensation and re-evaluation of acceleration processes.
- *It turns out that the electrons needed to produce these $\gamma$-rays are fraction of the Crab polar cap voltage.*
Magnetospheric balance between electric and magnetic forces $\rightarrow$ CKF
• At the termination shock, the balance can be disturbed.
• Bringing the (+) and (-) regions closer could increase $E$ to have particles close the circuit.
• These particles could get a fraction of the total potential voltage across the polar cap.
• This will lead to synchrotron emission at energies larger than the maximum obtained from shock acceleration.
• Clearly these are not detailed arguments by any sense.

• However, if correct, imply a correlation between the polar cap $V$ and the $\gamma_{\text{max}}$ of PWN \textit{(it is not inconsistent with the $\gamma \sim a \text{ few } x 10^8$ of Vela estimated in Pavlov et al. 2003)}.

• Detailed simulations of this process (reconnection?) should bear in mind that different field lines correspond to different values of the polar cap $V$. 