SPACE AND COSMIC RAY PHYSICS ONLINE SEMINAR

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Massive Star Explosions: Pandora Boxes for Cosmic Ray Particles and Maximally Rotating Black Holes?

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What is the physical process that gives the same Cosmic Ray knee and Cosmic Ray ankle energy for all Super-Nova (SN) explosions that contribute strongly to particles in that energy range, PeV to EeV? Why do the observed stellar mass black holes (BHs) show negligible spin before merging? There are two typical energies in the spectrum of cosmic rays, the *knee* energy $E_{CR,knee}$, where the spectrum turns down, and the *ankle* energy $E_{CR,ankle}$, with $E_{CR,knee} \simeq E_{CR,ankle}\,(V_{SN}/c)^2$: Both energies are proportional to $e\,B\,r$, observed in wind-SNe and the numbers match. That energy squared is proportional to the angular momentum transport in an observed Parker type wind of a wind-SN (Parker 1958, Weber & Davis 1967). So our proposal to interpret these observations is: A freshly formed stellar mass BH of maximal rotation rapidly loses its spin (A. Chieffi). The observations suggest $(e\,B\,r)^2 = m_X\,m_{Pl}\,c^4$ with m_X of order GeV; with an error of $10^{\pm 0.24}$ (M. Allen, P.P. Kronberg). This expression can be interpreted as a maximal Penrose process using $p\,\bar{p}$ or e^+e^- pairs. Spin-down gives a luminosity scale: $L_{rot} = (\hbar\,c)/(e^2)\;(m_X\,c^2)/(\tau_{Pl})$. This is analogous to the luminosity scale for BH mergers, called the Planck luminosity: $L_{GW} = (m_{Pl}\,c^2)/(\tau_{Pl})$. In this latter expression the quantity $\hbar$ scales out, as it is equal to c^5/G_N. In the spin-down expression $\hbar$ does not scale out, so we can ask speculatively: might this be the signature of a combination of General Relativity with Quantum Mechanics based on observations? Both times, the characteristic time scales with the BH mass, while the luminosity scale is independent of BH mass. The EHT observations of the super-massive black hole in the galaxy M87 are consistent with the values for the product $B\,r$ of massive star SNe as well as the observed luminosity. The quantum mechanical model of BHs (R. Casadio) may allow to let us understand these observations.