$\mp\Phi$ about the 2-axis at $\phi = \pm\Phi$ respectively,

$$|p^a_\pm, \uparrow; \pm\Phi\rangle' = \cos(\frac{\Phi}{2})\,|p^a_\pm, \uparrow; \pm\Phi\rangle \pm \sin(\frac{\Phi}{2})\,|p^a_\pm, \downarrow; \pm\Phi\rangle\,, \quad (35)$$

$$(36)$$

$$|p^a_\pm, \downarrow; \pm\Phi\rangle' = \mp \sin(\frac{\Phi}{2})\,|p^a_\pm, \uparrow; \pm\Phi\rangle + \cos(\frac{\Phi}{2})\,|p^a_\pm, \downarrow; \pm\Phi\rangle\,, \quad (37)$$

As in [1],

$$\frac{1}{\sqrt{2}}\Big[\cos(\Delta)\big(\,|p^a_+, \uparrow; \Phi\rangle'\,|p^a_-, \downarrow; -\Phi\rangle' - |p^a_+, \downarrow; \Phi\rangle'\,|p^a_-, \uparrow; -\Phi\rangle'\,\big) + \sin(\Delta)\big(\,|p^a_+, \uparrow; \Phi\rangle'\,|p^a_-, \uparrow; -\Phi\rangle' + |p^a_+, \downarrow; \Phi\rangle'\,|p^a_-, \downarrow; -\Phi\rangle'\,\big)\Big] \quad (38)$$

is found to describe the state, where

$$\Delta = \Theta - \Phi = \Phi\left[\frac{r}{\sinh(\zeta)}\vartheta^1{}_3 - 1\right] \quad (39)$$

Since the trivial rotation has been removed it is clear that a real deterioration of the perfect correlation between the spins is being observed, however only local unitary operations have been applied and the entanglement is invariant under unitary operations. Hence this must be an affect of the acceleration and gravity. If the pure state can be recovered then quantum computations may still be done while in the presence of a gravitational field. In particular the respective observers at $\phi = \pm\Phi$ must take measurements at an angle $\mp\Theta$ in their local inertial frames. Since $\vartheta^a{}_b(x) \neq \chi^a{}_b(x)$ a parallel transport would not reproduce this angle. Hence by transforming in the appropriate direction the full EPR correlation may still be recovered.

Now it was found that Δ is positive for $r \to \infty$ to a radius r_0 very close to the outer horizon r_+. As r becomes smaller than r_0 and furthermore $r \downarrow r_+$, $\Delta \to -\infty$ and thus to extract the perfect EPR correlation each observer would require infinite accuracy in the measurement that even a small error would lead to a mixed state element.

IV. THE INFALLING OBSERVER

We adopt the Doran [4] metric to remove the coordinate singularities of the metric. The observer can now fall through the apparent singularities of the Kerr-Newman spacetime observed by an observer at infinity. For this observer the line element is given by

$$ds^2 \;=\; -dT^2 + \left[\frac{\Sigma}{\Omega}dR + b\,\frac{\Omega}{\Sigma}\left(dT - a\sin^2(\theta)\,d\phi\right)\right]^2 + \Sigma^2 d\theta^2 + \Omega^2\sin^2(\theta)\,d\phi^2 \quad (40)$$

where

$$\Omega = \left(\mathrm{R}^2 + a^2\right)^{\frac{1}{2}}$$
$$b = \frac{\left(2MR - Q^2\right)^{\frac{1}{2}}}{\Omega}$$
$$\Sigma = \left(R^2 + a^2\cos^2(\theta)\right)^{1/2} \quad (41)$$

and the time coordinate coincides with the proper time for the free fall observer. The vierbein is now chosen to be,

$$\tilde{e}_0{}^\mu(x) = (1, 0, 0, 0)$$
$$\tilde{e}_1{}^\mu(x) = \left(b\,\frac{\Omega}{\Sigma}, \frac{\Sigma}{\Omega}, 0, -a\,b\sin^2(\theta)\;\frac{\Omega}{\Sigma}\right)$$
$$\tilde{e}_2{}^\mu(x) = (0, 0, \Sigma, 0)$$
$$\tilde{e}_3{}^\mu(x) = (0, 0, 0, \Omega\,\sin(\theta)) \quad (42)$$

In the (t, r, θ, ϕ) coordinates the vierbein inherited the r_+ and r_- coordinate singularities, the above (T, R, θ, ϕ) also act as the metric does at those radii, and since the metric is singularity free there so is the vierbein. Now similarly to Eq.(5) we take a four velocity of the form,