Comment on the Black Hole in Markarian 1018

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It has been reported by Huseman *et al** that the active galactic nucleus of Mrk 1018 has likely changed optical type due to the effects of a supermassive black hole (SMBH) of the Schwarzschild type, or a binary system consisting of two such black holes:

> "*we assume a Schwarzschild BH with fixed $M_{BH} = 108M_\odot$. ...Based on the appearance of a new NAL in Lyα we speculate whether the onset of an outflow or a putative binary SMBH system is driving instabilities in the accretion disc causing the declining luminosity.*"

It is impossible for any type or form of black hole to be involved with Mrk 1018 because the mathematical theory of black holes violates the rules of pure mathematics.

The 'Schwarzschild solution', for $R_{\mu\nu} = 0$, is:

$$ds^2 = \left(1 - \frac{2m}{r}\right)dt^2 - \left(1 - \frac{2m}{r}\right)^{-1} dr^2 - r^2 d\Omega^2$$
$$d\Omega^2 = \left(d\theta^2 + \sin^2\theta\, d\varphi^2\right), \quad 0 \le r \tag{1}$$

The quantity r in (1) can be replaced by any analytic function of r without violating spherical symmetry or $R_{\mu\nu} = 0$. However, not any analytic function of r is admissible because the solution must satisfy Einstein's prescription:

1. It must be static.
2. It must be spherically symmetric.
3. It must be asymptotically flat.

There exists an infinite equivalence class of solutions for $R_{\mu\nu} = 0$, thereby constituting all admissible 'transformations of coordinates'. If any element of this infinite equivalence class cannot be extended to produce a black hole then none can be extended, owing to equivalence. The infinite equivalence class is given by:

$$ds^2 = \left(1 - \frac{\alpha}{R_c}\right)dt^2 - \left(1 - \frac{\alpha}{R_c}\right)^{-1} dR_c^2 - R_c^2 d\Omega^2$$
$$d\Omega^2 = \left(d\theta^2 + \sin^2\theta\, d\varphi^2\right) \tag{2}$$
$$R_c = \left(|r - r_0|^n + \alpha^n\right)^{\frac{1}{n}}, \quad r, r_0 \in \Re, n \in \Re^+$$

wherein r_0 and n are arbitrary constants, α a positive real-valued constant, and $r = \sqrt{(x - x_0)^2 + (y - y_0)^2 + (z - z_0)^2} + \sqrt{x_0^2 + y_0^2 + z_0^2} = r' + r_0$. It follows immediately that no element of (2) can be extended because $|r - r_0|^n \ge 0$. The line-element (1) cannot be extended to $0 \le r$ to produce a black hole because it is an element of the class (2). Consequently, $0 \le r$ in (1) is invalid because it implies a violation of the rules of pure mathematics. This is amplified by the case $r_0 = \sqrt{x_0^2 + y_0^2 + z_0^2} = 0, n = 2$. Schwarzschild's original form is recovered by selecting $r_0 = 0, n = 3, r_0 \le r$.

According to cosmology there are four types of black hole. All related solutions must be elements of an infinite equivalence class that reduces to (2). The overall infinite equivalence class is given by:

$$ds^2 = \frac{a^2\sin^2\theta - \Delta}{\rho^2}dt^2 - \frac{2a^2\sin^2\theta\left(R_c^2 + a^2 - \Delta\right)}{\rho^2}dtd\varphi +$$
$$+ \frac{\left(R_c^2 + a^2\right)^2 - a^2\Delta\sin^2\theta}{\rho^2}\sin^2\theta\, d\varphi^2 + \frac{\rho^2}{\Delta}dR_c^2 + \rho^2 d\theta^2$$
$$\Delta = R_c^2 - \alpha R_c + a^2 + q^2, \quad \rho^2 = R_c^2 + a^2\cos^2\theta,$$
$$R_c = \left(|r - r_0|^n + \xi^n\right)^{\frac{1}{n}}, \quad \xi = \frac{\alpha + \sqrt{\alpha^2 - 4q^2 - 4a^2\cos^2\theta}}{2}$$
$$a^2 + q^2 < \frac{\alpha^2}{4}, \quad r, r_0 \in \Re, n \in \Re^+$$
$$r = \sqrt{(x - x_0)^2 + (y - y_0)^2 + (z - z_0)^2} +$$
$$+ \sqrt{x_0^2 + y_0^2 + z_0^2} = r' + r_0 \tag{3}$$

No element of the infinite equivalence class (3) can be extended to produce a black hole without violating the rules of pure mathematics; again amplified by the case $r_0 = 0, n = 2$.

NOTE: Submitted to the editors, *Astronomy & Astrophysics* on 18 September 2016.

*Huseman, B. *et al.*, The Close AGN Reference Survey (CARS), What is causing Mrk 1018's return to the shadows after 30 years?, *Astronomy & Astrophysics*, 4 July 2016