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Generalized Hidden Symmetries and the Kerr-Sen Black Hole

by

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ref.) HKWY1 (1002.3616), HKWY2 (1004.1032)

Black Holes in a Vacuum

■ Vacuum black hole solutions

● 4 dimension

Schwarzschild (1916)

Kerr (1963)

Carter (1968)

Plebanski (1975)

● Higher dimensions ($D > 4$)

Tangherlini (1916)

Myers, Perry (1986)

Hawking, et al. (1998) (5-dim)

Gibbons, Lu, Page, Pope (2004)

Chen, Lu, Pope (2006)

■ Algebraic properties

A closed CKY 2-form exists.

Carter (1987), Kubiznak, Frolov (2007)

Geodesic motion is integrable. ←

Carter (1968), Page, et al. (2007)

Curvature is of type-D. ←

Petrov (1954), Hamamoto, et al. (2007)

H-J equation is separable. ←

K-G equation is separable. ←

Carter (1968), Frolov, Krtous, Kubiznak (2007)

Symmetry operators exist
for K-G equation. ←

Carter (1977), Sergyeyev, Krtous (2007)

Dirac equation is separable. ←

Chandrasekhar (1976), Oota, Yasui (2008)

Symmetry operators exist
for Dirac equation. ←

Carter, McLenaghan (1979),
Benn, Charlton (1996)

Conformal Killing-Yano (CKY) Tensor

■ Killing(-Yano) symmetry

There are two generalizations of Killing and conformal Killing vectors to higher-rank tensors.

	Killing vector	conformal Killing vector
symmetric	Killing tensor	conformal Killing tensor
anti-symmetric	Killing-Yano (KY) Yano (1952)	conformal Killing-Yano (CKY) Tachibana (1968), Kashiwada (1969)

■ CKY p-form (rank-p CKY tensor)

Def. A p-form \mathbf{h} is called **CKY p-form**, when it satisfies for an arbitrary vector \mathbf{X} the equation

$$\nabla_{\mathbf{X}} \mathbf{h} = -\frac{1}{D-p+1} \mathbf{X}^b \wedge \delta \mathbf{h} + \frac{1}{p-1} i(\mathbf{X}) d\mathbf{h} .$$

Especially, a CKY p-form is called

[closed CKY p-form, when $d\mathbf{h} = 0$
	Killing-Yano p-form, when $\delta \mathbf{h} = 0$

Generalized Conformal Killing-Yano (GCKY) Tensor

■ Generalized Killing-Yano symmetry

Kubiznak, Kunduri, Yasui (2009)

They introduced **3-form torsion** into the CKY equation.

$$\nabla_X^T h = -\frac{1}{D-p+1} X^\flat \wedge \delta^T h + \frac{1}{p-1} i(X) d^T h$$

In considering supergravities, it is natural to introduce 3-form torsion because it is identified with Maxwell fields or 3-form flux.

In my poster, we discuss the algebraic properties connecting with conformal Killing-Yano forms in the presence of torsion.