(4) A BASIS

FOR

(3) GENERALIZED PERTURBATIONS

OF THE

(2) KERR BLACK HOLE,

(1) ETC.

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(4) WORK IN PROGRESS
(WITH LARRY PRICE, UF)

(2) BEYOND SCHWARZSCHILD

(3) NOT JUST ON SHELL
(cf CHRZANOWSKI)

(1) ETC $\Rightarrow$ all type D ?

BASED ON N-P FORMALISM

c.f. REGGE-WHEELER DECOMPOSITION

- $H_0, H_1, H_2, K + T_n$ 'ς' — SCALAR* PART.

  h_0, h_1 - VECTOR* PARTS

  $T_n F_{nm}$ 'ς', h_2 - 2-TENSOR* PARTS

- GAUGES GIVE PIECES OF <u>SAME</u> FORM

- A GENERAL PERTURBATION CAN BE DESCRIBED (I.E. NON-ZERO SOURCES)

SCHWARZSCHILD SEEMS VERY SPECIAL

$$\boxed{\begin{array}{l}\text{IF NOT SO ...} \\ \text{HOW TO GENERALIZE?}\end{array}}$$

* ON CLOSED 2-SURFACES (SPHERES)

FURTHER INSPECTION...

DEFINE $h_0 = h_0^e Y_{lm} + i h_0^o Y_{lm}$, $h_2 = \text{T.F. } \xi' + i$

THEN VECTOR PART GIVEN BY

$$\bar{\eth} h_0 \quad (+\text{ c.c.})$$

TENSOR PART $\bar{\eth}\bar{\eth} h_2$ (+ c.c.)

(WHERE $\eth$ = N.P. OPERATOR)

ACTUALLY, h_0, h_2 SCALARS

VECTORS – SPIN 1

TENSORS – SPIN 2

- SUGGESTION: N.P. SPIN WEIGHT (AND BOOST WEIGHT) MAY BE USEFUL TO BOOTSTRAP BEYOND SCHWARZSCHILD PERTURBATIONS.

CHECK WITH CHRZANOWSKI ?

$m^* m^*$ $\quad D D ({}_{-2}R_{+2}Z) \Rightarrow (0, 2)$

$m m$ $\quad \Delta \Delta ({}_{+2}R_{-2}Z) \rightarrow (0, -2)$

THESE ARE EXACTLY SPIN-2 PARTS.

$\ell \ell$ $\quad \bar{\delta} \bar{\delta} ({}_{-2}R_{+2}Z) \rightarrow (-2, 0)$

$n n$ $\quad \delta \delta ({}_{+2}R_{-2}Z) \rightarrow (+2, 0)$

THESE ARE 2-SURFACE SCALARS.

SO: IDEA HOLDS, BUT ...

- NO ℓn $\quad m \bar{m}$ PARTS (SCALARS) (e.g. NO $\ell=0$, $\ell=1$ PARTS)

- NO GAUGE DESCRIPTION GIVING METRIC IN SAME FORM

- NO OFF-SHELL FORMULATION.

REALLY MANY COMPLICATIONS

E.G. SPIN-2:

R-W	SS	$\bar{S}\bar{S}$
CHRZ	DD	$\Delta\Delta$

- THESE ACT ON GAUGE VECTOR — THESE DO

- ACTUALLY, <u>EVERY</u> OPERATOR HAS SPIN COEFFICIENT ADDITIONS!

- SO, CAN'T JUST USE GAUGE VECTOR IN N.P. FORM.

  (+)

- STILL NEED TO FORMULATE NON-G.W. PARTS

- AND DEAL WITH SOURCES

  (+)

- WHAT TO SAY ABOUT

$$h_{\mu\nu} = \alpha_0 h^{I}_{\mu\nu} + \beta \cdot h^{0}_{\mu\nu} \; ?$$

WHAT TO DO ?

CHRZ USES $\;{}_{+2}R_{+2}Z,\; {}_{+2}R_{-2}Z,\; {}_{-2}R_{+2}Z,\; {}_{-2}R_{-2}$

- SO USE THESE TO DEFINE NP SCALAR

  EG $\qquad \Delta\Delta\bar{\delta}\bar{\delta}\left({}_{+2}R_{+2}Z\right)$, etc.

- THEN USE TEUKOLSKY COMMUTATORS

$$D_{AB}\,S_{CD} = S_{ab}\,D_{cd}$$

- THEN USE T.S. IDENTITIES

$$\bar{\delta}\,\bar{\delta}\,\bar{\delta}\,\bar{\delta}_{+2}Z \longrightarrow \text{CONST.}\;{}_{-2}Z\,.$$

THESE WOULD IMPLY

- CAN INCORPORATE GAUGE

- CAN WORK OFF-SHELL
  (I.E. INDEPENDENT COEFFS, AS IN H_0, H_1 ..

- I.E. CAN DESCRIBE GENERAL PERTURBATION

RESULTS SO FAR

- START WITH SCALARS
  EG.
  $$\xi = l\,\Delta(A) + n\,D(B) - m\,\bar{\delta}(C) - \bar{m}\,\delta($$
- DEFINE METRIC PERTURBATIONS AND GAUGE TRANSFORMATIONS
- COMPARE WITH USUAL (EG. R-W) DECOMPOSITION

NOW THE HARD PART

- ADD IN SCALAR DEFINITIONS
- USE COMMUTATORS (N.P., Tenk)
- REDUCE DERIVATIVES (T.S)

THEN

- PUT IT ALL TOGETHER
- USE IT FOR A CALCULATION