

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)

④ ETC  $\Rightarrow$  all type D ?

## BASED ON N-P FORMALISM

c.f. RESSE-WHEELER DECOMPOSITION

•  $H_0, H_1, H_2, K + T_{\alpha} 'G'$  - SCALAR $\xi^{\alpha}$  PART

$h_0, h_1$  - VECTOR $\xi^{\alpha}$  PARTS

$T_{\alpha} \text{ Form } 'G', h_2$  - 2-TENSOR $\xi^{\alpha}$  PARTS

- CAUSES GIVE PIECES OF SAME FORM
- A GENERAL PERTURBATION CAN BE DESCRIBED (I.E. NON-ZERO SOURCES)

SCHWARZSCHILD SEEMS VERY SPECIAL

IF NOT SO ...

HOW TO GENERALIZE?

• ON CLOSED 2-SURFACES (SPHERES)

## FURTHER INSPECTION...

DEFINE  $h_0 = h_0^{\text{ey}} + i h_0^{\text{oy}}$ ,  $h_2 = \text{T.F. } \zeta' + i$

THEN VECTOR PART GIVEN BY

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

TENSOR PART  $\bar{S} \bar{S} h_2 \quad (+ \text{c.c.})$

(WHERE  $S = \text{N.P. OPERATOR}$ )

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 ?

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

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

THESE ARE EXACTLY SPIN-2 PARTS.

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

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

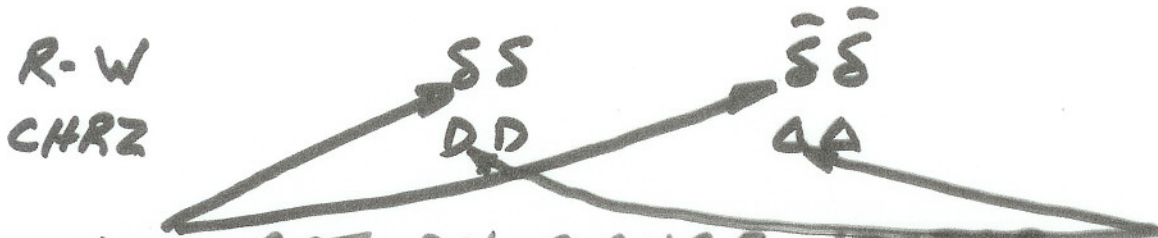
THESE ARE 2-SURFACE SCALARS.

SO: IDEA HOLDS, BUT ...

- NO  $l n$   $m \bar{m}$  PARTS (SCALARS)  
(c.f. NO  $l=0, l=1$  PARTS)
- NO GAUGE DESCRIPTION GIVING METRIC IN SAME FORM
- NO OFF-SHELL FORMULATION.

# REALLY MANY COMPLICATIONS

EG. SPIN-2:



- THESE ACT ON GAUGE VECTOR THESE DO
- ACTUALLY, EVERY 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
 
$$h_{\mu\nu} = \alpha \cdot h_{\mu\nu}^I + \beta \cdot h_{\mu\nu}^0 \quad ?$$

## WHAT TO DO ?

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

- SO USE THESE TO DEFINE NP SCALAR

$$\text{E.G. } \Delta\Delta\bar{\delta}\bar{\delta}({}_{+2}R_{+2}Z), \text{ etc.}$$

- THEN USE TEUKOLSKY COMMUTATORS

$$D_{AB}\delta_{CD} = \delta_{AB}D_{CD}$$

- THEN USE T.S. IDENTITIES

$$\bar{\delta}\bar{\delta}\bar{\delta}\bar{\delta}_{+2}Z \rightarrow \text{CONST. } {}_{-2}Z.$$

THESE WOULD IMPLY

- CAN INCORPORATE GAUGE
- CAN WORK OFF-SHELL  
(I.E. INDEPENDENT COEFFS, AS IN  $H_0, H_1, \dots$ )
- I.E. CAN DESCRIBE GENERAL PERTURBATION

## RESULTS SO FAR

- START WITH SCALARS  
ES.

$$\xi = \int \Delta(A) + \eta D(B) - m \bar{\delta}(c) - \bar{m} \delta(c)$$

- DEFINE METRIC PERTURBATIONS  
AND GAUGE TRANSFORMATIONS
- COMPARE WITH USUAL (E.S. R-W)  
DECOMPOSITION

## NOW THE HARD PART

- ADD IN SCALAR DEFINITIONS
- USE COMMUTATORS ( $N_P$ ,  $T_{ab}$ )
- REDUCE DERIVATIVES (T.S)

## THEN

- PUT IT ALL TOGETHER
- USE IT FOR A CALCULATION