

STEPS TOWARD
METRIC PERTURBATIONS
IN THE KERR SPACE-TIME

BERNARD WHITING[̄]
(WITH LARRY PRICE^I
& CARLOS LOUSTO^{II})

OUTLINE

- TRADITIONAL METHODS
(cf PREVIOUS TWO DAYS)
- GHP BASED METHOD
(cf PREVIOUS TALK(s))
- GHP TOOLS
- " " APPLICATIONS
- GHP (NP) PRIMER
- GOOD INTENTIONS
- ACTUAL RESULTS
- REALISTIC PLANS (BEWARE!)

UNOFFICIAL SUMMARY

- NO PN TO NTH ORDER
- NO SL TO 2ND ORDER
- REAL RESULTS
 - MAPLE
 - FORMALISM
 - EQUATIONS
- OBSTACLES FOR KERR
 - IDENTIFIED
 - SURMOUNTABLE
- WORK IN PROGRESS!

TRADITIONAL METHODS (IN SCHWARZSCHILD)

- DECOUPLE DEGREES OF FREEDOM
- CHOICE OF CONVENIENT GAUGE
- SEPARATION OF VARIABLES (MODAL DECOMPOSITION)
- RECOGNISE SUITABLE GAUGE INVARIANTS
- "RANDOM" CALCULATIONAL METHODS EMPLOYED!
- METRIC RECONSTRUCTION.
(cf LOUSTO)

GHP BASED METHOD

- DEFINED "WEIGHTS" (cf N.P.)
 - SPIN $m^a \rightarrow e^{i\theta} m^a$ $\bar{m}^a \rightarrow e^{-i\theta} \bar{m}^a$
 - BOOST $l^a \rightarrow \lambda l^a$ $n^a \rightarrow \lambda^{-1} n^a$
- WORK ENTIRELY WITH QUANTITIES OF WELL-DEFINED WEIGHT
- ALL EQUATIONS HAVE WELL-DEFINED WEIGHT
- ALL OPERATIONS HAVE WELL-DEFINED WEIGHT.
- FORM OF EQUATIONS HAS DISCRETE SYMMETRIES (NOT GEOMETRICAL!)

APPLICATIONS OF GHP TOOLS

- UNDERSTAND RADIATION GAUGES
- DEVELOP PERTURBED EINSTEIN EQUATIONS IN NP (GHP) FORM
- IDENTIFY & IMPLEMENT R-W GAUGE IN GHP FORM
- SELECT PARITY WITHOUT ANGULAR DECOMPOSITION.
- CREATE R-W EQUATION (ACTING ON GAUGE INVARIANT PARITY) $I_m(\delta \Psi_{\dots})$ - SO FAR, IN R-W GAUGE

GHP TOOLS (L. PRICE)

- TENSOR ALGEBRA
(CONTRACTIONS, COMMUTATORS)
- RECOGNIZE AND KEEP TRACK
OF SPIN & BOOST WEIGHT
- APPLY WELL-DEFINED
WEIGHTED OPERATORS.
- EINSTEIN EQUATIONS
- BIANCHI IDENTITIES
(- FULL NP FORMALISM)
- GHP \leftrightarrow COORDINATES.

INTENTIONS (SO FAR)

- DEVELOP APPROACH COMPARABLE OF THAT OF R-W & Z-M FOR SCHWARZSCHILD
- NB: CANNOT EXPECT Z EQUATION FOR KERR!
- WORK WITH T. IN MORE SUITABLE GAUGE (cf LOUSTO)
- RECOGNIZE IMPORTANCE OF GAUGE INVARIANTS (cf NOLAN)
- ACCOMMODATE SOURCES. (cf LOUSTO & WHITING)

R-W EQUATION FOR $I_m(\delta\psi_2)$

ξ_{11} P (GAUGE CONDITION)

ξ_{22} P' (GAUGE CONDITION)

ξ_{2m} }
..... }
 $\xi_{m\bar{m}}$ } \Rightarrow R-W EQUATION

ξ_{mm} χ (SUBSIDIARY CONDITION)

$\xi_{\bar{m}\bar{m}}$ χ' (SUBSIDIARY CONDITION)

\uparrow

RELATES χ_{12} & χ_{21}

• '2p' OBSTACLES IN EVERY EQUATION FOR Kerr!

LESSONS SO FAR

- INSIST ON GAUGE INVARIANCE
(E.F. RICHARD PRICE)

- CAPITALIZE ON STRUCTURE OF QHP FORMALISM

- eg $\rho_{\bar{m}}$ PART OF $\xi_{\rho m}$
 $\gamma' \rho'$ $\gamma \gamma h_{\rho \bar{m}} \rightarrow \gamma' \gamma (P' \gamma h_{\rho \bar{m}})$

and u_m PART OF $\xi_{\rho m}$
 $\gamma' \rho'$ $\gamma' \rho h_{\rho m} \rightarrow P' \rho (\gamma' \gamma h_{\rho m})$

and u_m PART OF $\xi_{\rho m}$
 $\gamma' \rho'$ $\rho \rho h_{\rho m} \rightarrow P' \rho (\gamma' \rho h_{\rho m})$

and ρ_m PART OF $\xi_{\rho m}$
 $\gamma' \rho'$ $\gamma \gamma' h_{\rho m} \rightarrow \gamma' \gamma (P' \gamma' h_{\rho m})$

- FOR GRAVITATIONAL SELF-FORCE
MUST RECONSTRUCT S_{ab}

COMPACT
EFFICIENT

REALISTIC PLANS

- "FIND" R-W EQUATION
WITHOUT GAUGE CHOICE
- SEEK COMPLETE SET OF
GAUGE INVARIANTS (IN NP FORM)
- "FIND" TEUKOLSKY EQUATION
IN NP FORM (EVEN FOR KERR)
- IDENTIFY & SOLVE
LOWER MULTIPOLE EQUATIONS
- CONSISTENTLY INCLUDE SOURCES

N.B. : • THESE ARE FINITE TASKS

• WE ALREADY HAVE THE TOOLS!