Some Comments on Results Achieved within the Students Project SGS 01/2010 (Bachelors and Masters Theses 2011)

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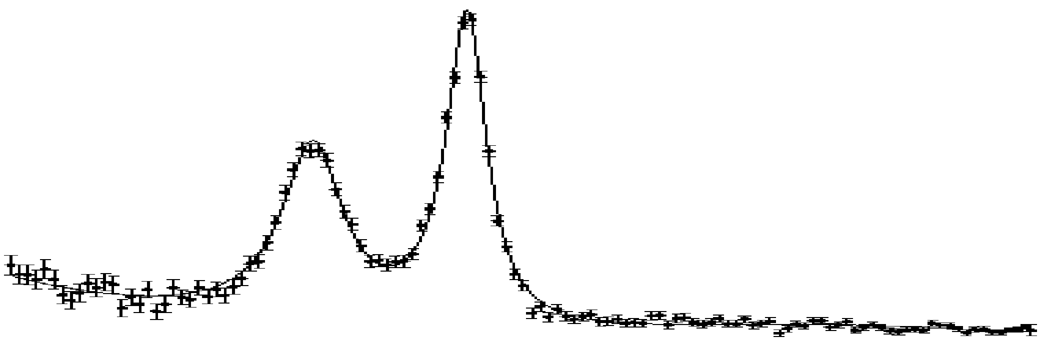

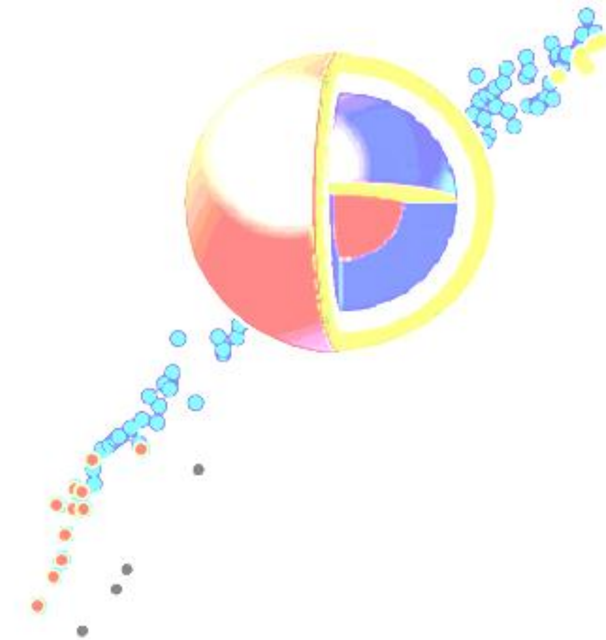

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In collaboration with
P. Čech, G. Chlopčíková, M. Wildner, K. Goluchová;
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M. Abramowicz, D. Barret, J. Horák, W. Kluzniak,
& J. Miller

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Some Comments on Results Achieved within the Students Project SGS 01/2010 (Masters Theses 2011)

Outline

I. Applicability of Kerr metric (NS) for QPO models (comparison to Hartle-Thorne metric)

II. Compactness of NS in terms of ISCO radii

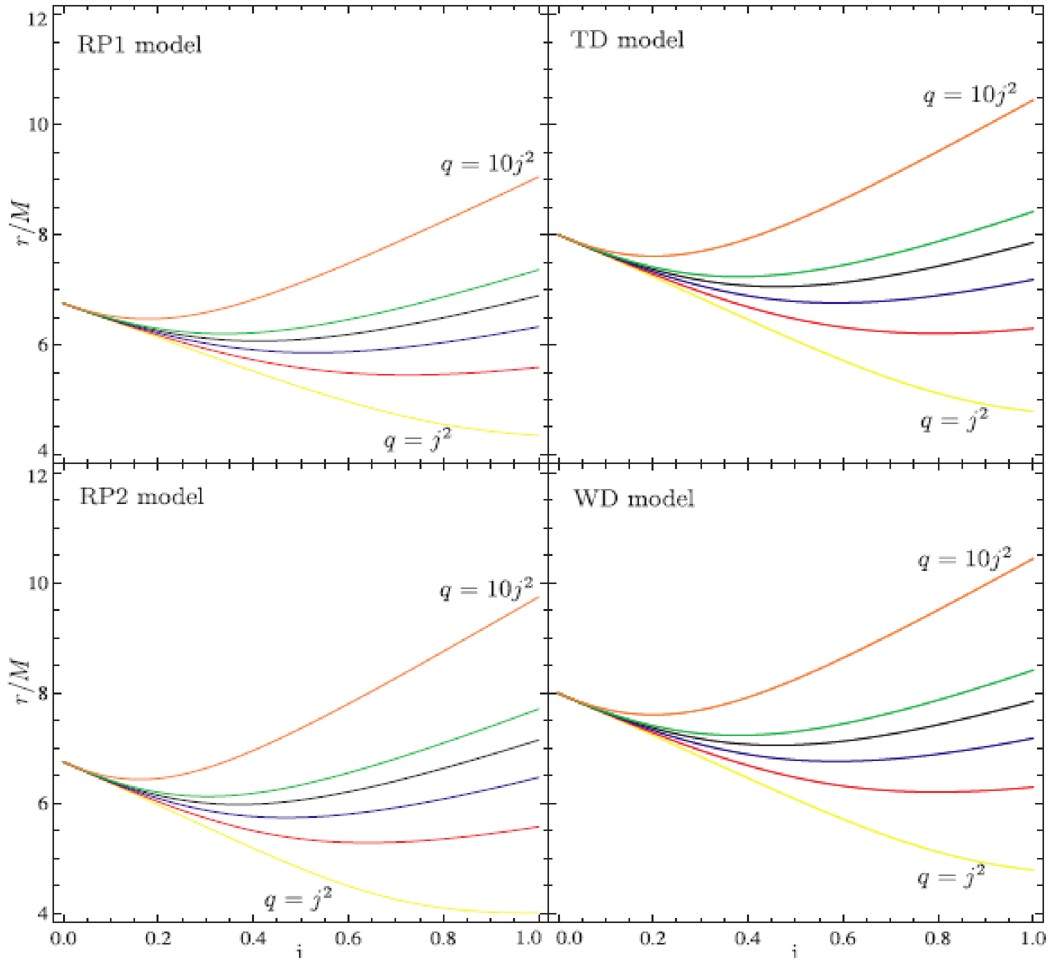
III. Importance of higher order terms in *j* for calculating ISCO (position and Keplerian orbital frequency) in HT spacetimes

IV. Summary + things to be done (or better say just completed)

I. Applicability of Kerr Metric (NS) for QPO Models

From masters thesis of Gabriela Chlopčíková:

QPO excitation radii in HT spacetime for various models



I. Applicability of Kerr Metric (NS) for QPO Models

From masters thesis of Gabriela Chlopčíková:

mass and angular momentum estimates based on simplified QPO data

Tabulka 3.3. Tabulka hmotností odpovídajících RP1 modelu.

$j = 0.1$						
q	j^2	$2j^2$	$3j^2$	$4j^2$	$5j^2$	$10j^2$
r/M	6.44	6.45	6.46	6.47	6.48	6.52
$M/M_\odot$	2.16	2.16	2.15	2.15	2.15	2.13
$j = 0.2$						
q	j^2	$2j^2$	$3j^2$	$4j^2$	$5j^2$	$10j^2$
r/M	6.13	6.17	6.21	6.25	6.29	6.47
$M/M_\odot$	2.28	2.27	2.25	2.24	2.22	2.17
$j = 0.3$						
q	j^2	$2j^2$	$3j^2$	$4j^2$	$5j^2$	$10j^2$
r/M	5.82	5.93	6.02	6.12	6.20	6.59
$M/M_\odot$	2.41	2.38	2.34	2.31	2.28	2.15
$j = 0.5$						
q	j^2	$2j^2$	$3j^2$	$4j^2$	$5j^2$	$10j^2$
r/M	5.23	5.58	5.86	6.10	6.31	7.12
$M/M_\odot$	2.71	2.56	2.45	2.36	2.28	2.02

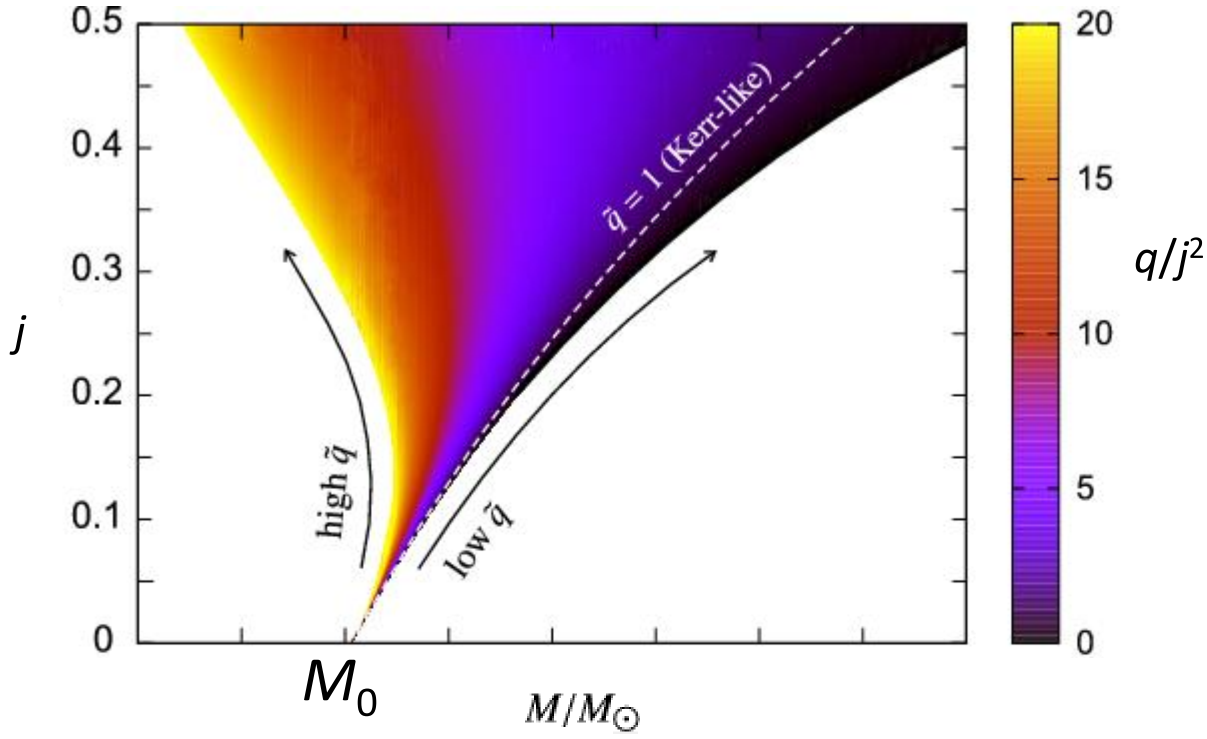
Tabulka 3.6. Tabulka hmotností odpovídajících ER modelu.

$j = 0.1$						
q	j^2	$2j^2$	$3j^2$	$4j^2$	$5j^2$	$10j^2$
r/M	10.26	10.27	10.28	10.29	10.31	10.36
$M/M_\odot$	1.08	1.08	1.08	1.08	1.08	1.07
$j = 0.2$						
q	j^2	$2j^2$	$3j^2$	$4j^2$	$5j^2$	$10j^2$
r/M	9.71	9.76	9.81	9.86	9.91	10.15
$M/M_\odot$	1.17	1.16	1.15	1.14	1.14	1.10
$j = 0.3$						
q	j^2	$2j^2$	$3j^2$	$4j^2$	$5j^2$	$10j^2$
r/M	9.14	9.27	9.40	9.52	9.64	10.16
$M/M_\odot$	1.26	1.24	1.22	1.20	1.18	1.10
$j = 0.5$						
q	j^2	$2j^2$	$3j^2$	$4j^2$	$5j^2$	$10j^2$
r/M	7.99	8.45	8.84	9.19	9.50	10.75
$M/M_\odot$	1.50	1.40	1.33	1.26	1.21	1.04

I. Applicability of Kerr Metric (NS) for QPO Models

Mass and angular momentum from a given QPO model:

(sketch based on some results of masters theses by G. Chlopčíková and P. Čech)

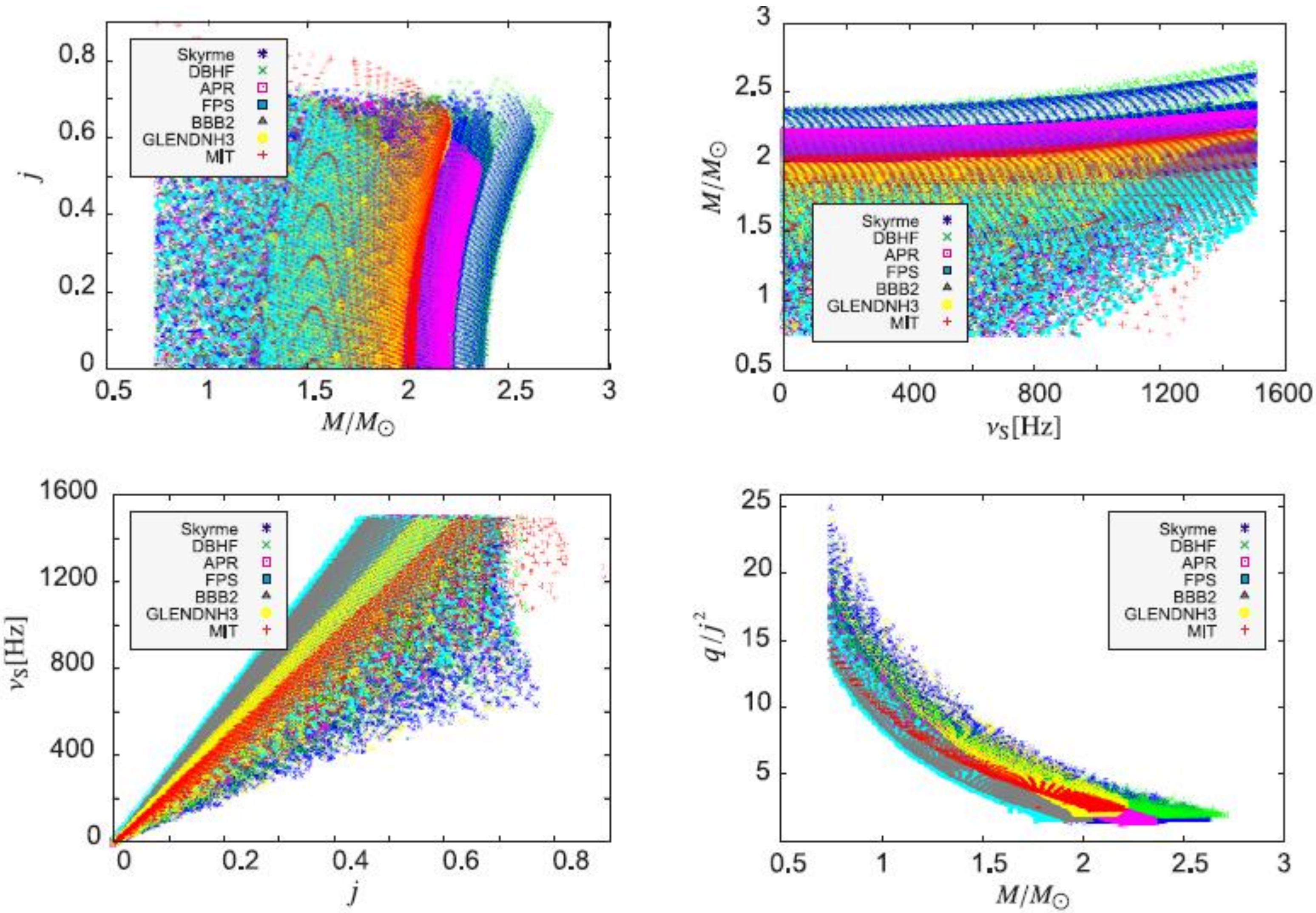


Example of concrete values of M_0 obtained by Gabriela:

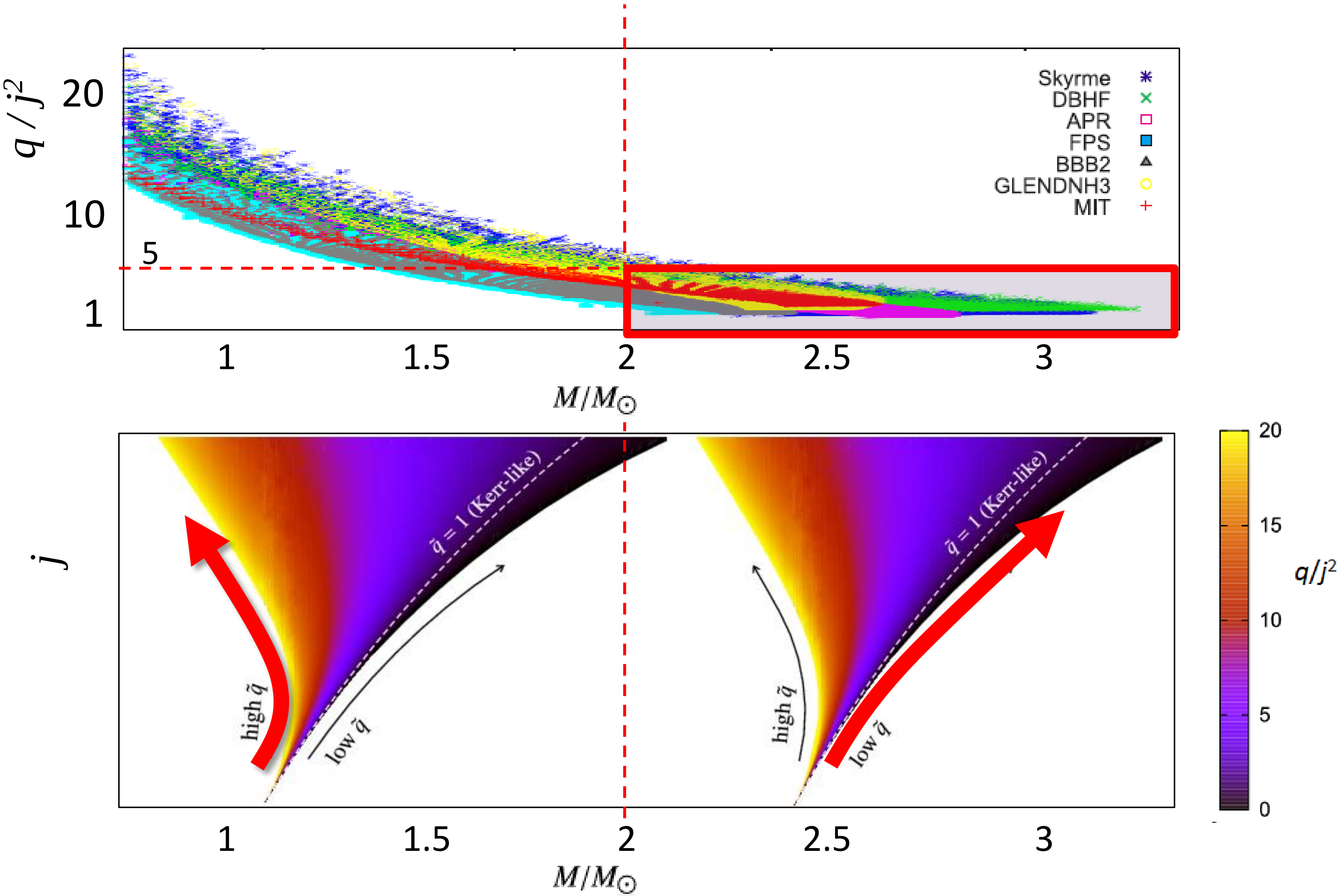
$$M^0_{\rm RP} = M^0_{\rm RP1} = M^0_{\rm RP2} = 2.05\,M_\odot, \quad M^0_{\rm TD} = M^0_{\rm WD} = 2.38\,M_\odot, \quad M^0_{\rm ER} = 1.01\,M_\odot.$$

I. Applicability of Kerr Metric (NS) for QPO Models

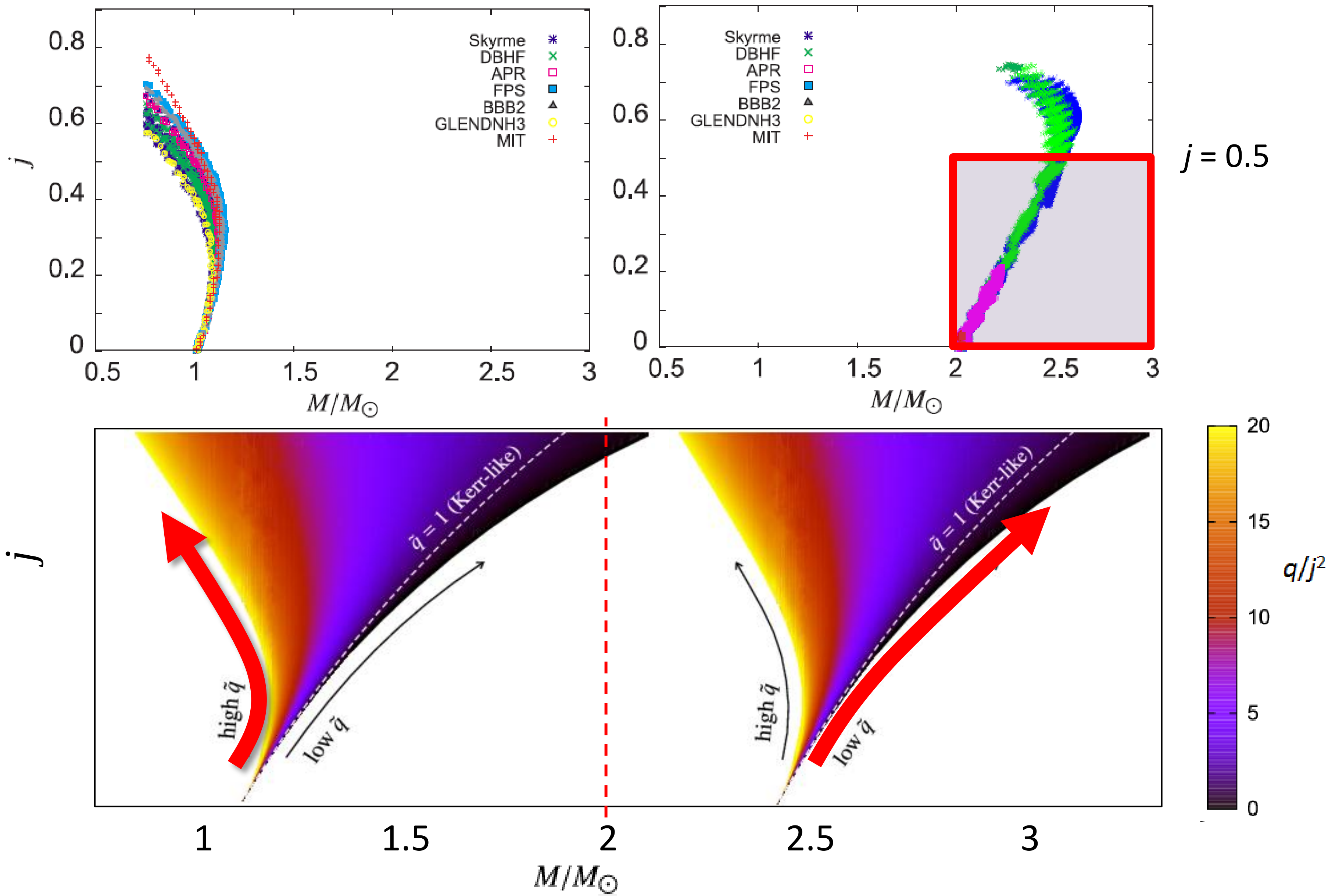
From masters thesis of Petr Čech: **Neutron star parameters obtained using the code DMT developed by Martin Urbanec** (10^7 configurations based on 18 different EoS)



I. Applicability of Kerr Metric (NS) for QPO Models

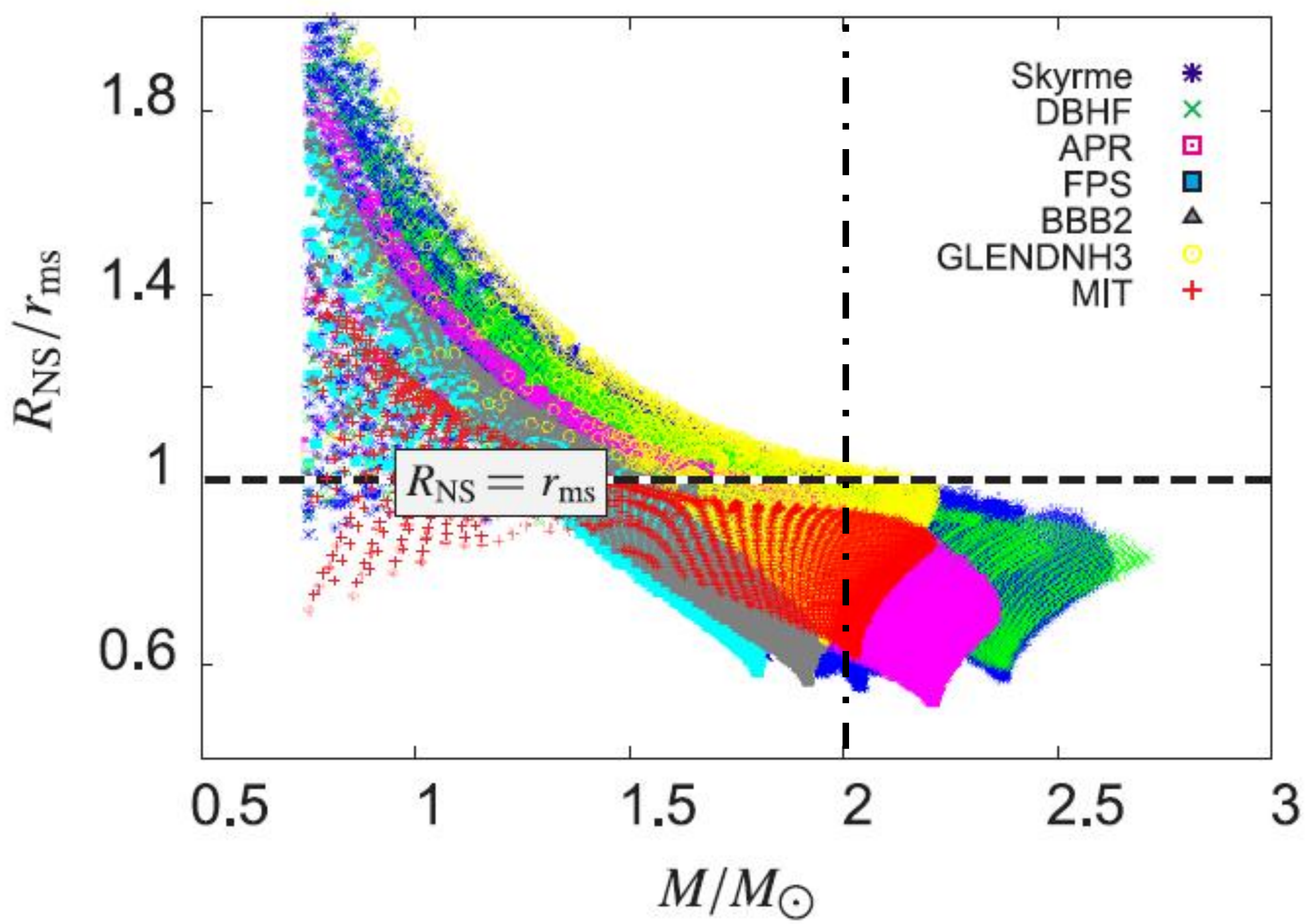


I. Applicability of Kerr Metric (NS) for QPO Models

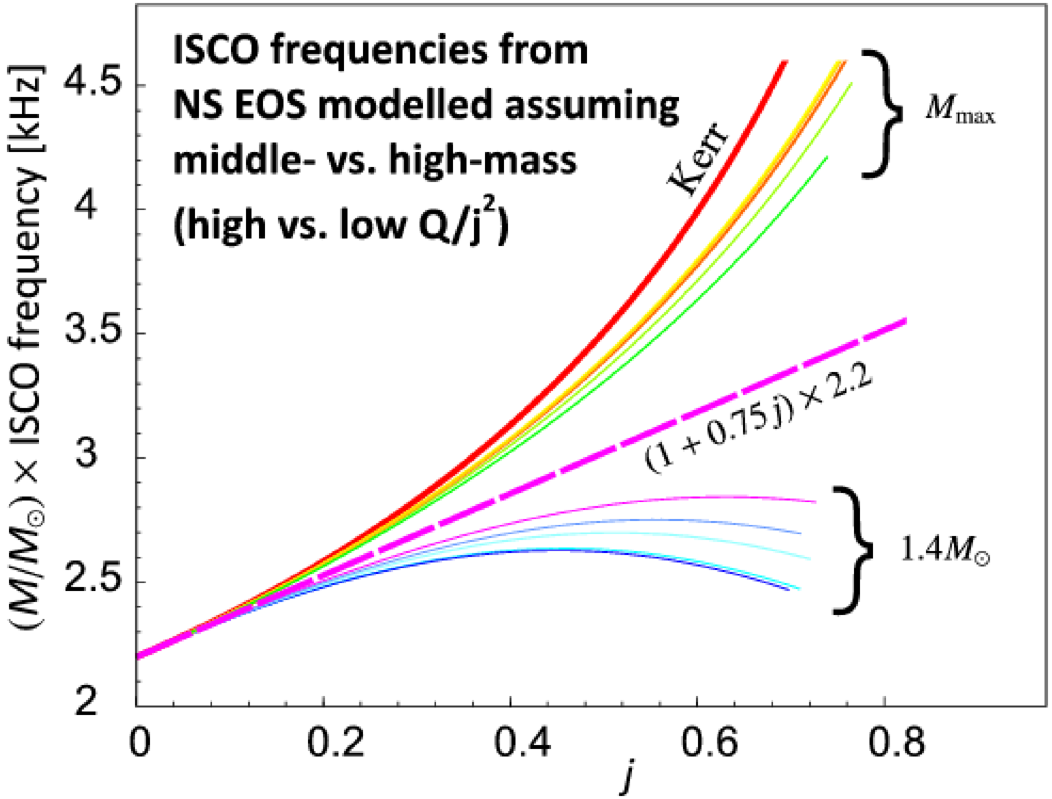


II. Neutron Star Compactness in Terms of ISCO Radii

From masters thesis of Petr Čech: Neutron star parameters obtained using the code DMT developed by Martin Urbanec (10^7 configurations based on 18 different EoS)



III. ISCO Radii – Troubles With Higher Order Terms in *j*

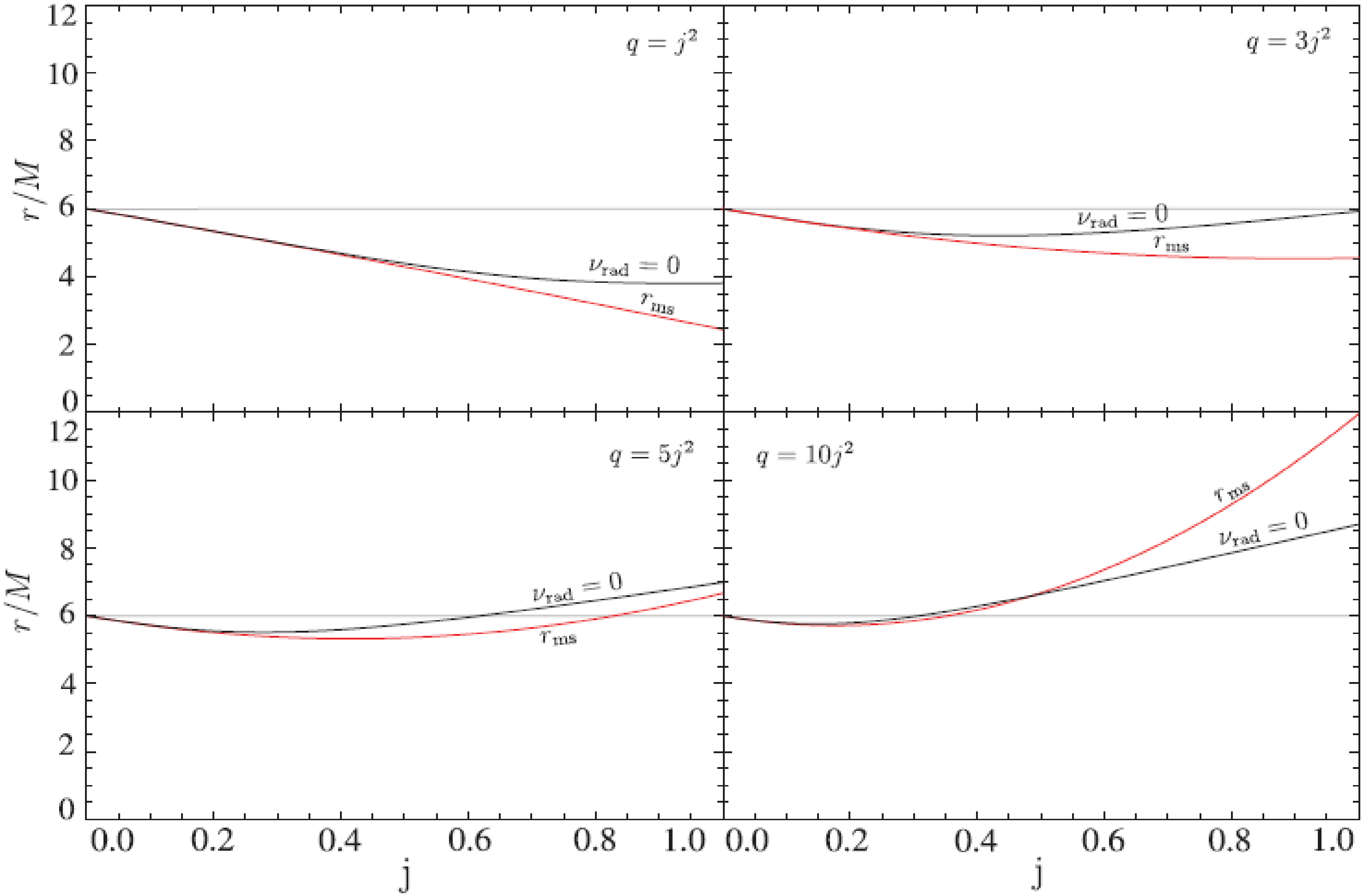


Torok et al., (2010),ApJ

➢ **figure based on HT formulaes, it well illustrates the applicability of Kerr metric for heavy NS; so far everything is nice…**

III. ISCO Radii – Troubles With Higher Order Terms in *j*

From masters thesis of Gabriela Chlopčíková: ISCO radii in HT spacetimes



- ➢ **ISCO calculated from nur=0 and directly from the profile of the Keplerian angular momentum do not agree fully which is a serious problem for calculations touching stars with masses below 1.4 x Msun and *j* >0.2**

IV. Summary

I. Applicability of Kerr metric (NS) for QPO models

- we can trust results based on Kerr for NS with *M* close to and above 2 solar masses and *j* up to *j*=0.5

II. Compactness of NS in terms of ISCO radii

- NS with *M* close to and above 2 solar masses are smaller than ISCO,
- NS below 1.4 solar masses are greater than ISCO

III. Importance of higher order terms in *j* for calculating ISCO

- for NS below 1.4xMsun we do not know (yet), whether we can trust formulaes for radial epicyclic frequency at low radii below the location of its maxima; the same is of course true for ISCO itself

IV. Things to be completed

- integrating results of G. Chlopčíková and P. Čech with the software for exact fitting of data (K. Goluchová) and numerical calculations of orbital frequencies in arbitrary axially symmetric situations

  (more in talk of P. Bakala)