Title: Merging numerical results with post-Newtonian analysis

Date: Jun 21, 2010 03:40 PM

URL: http://pirsa.org/10060052

Abstract: TBA

Merging numerical results with post-Newtonian analysis

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Outline

- Form of PN comparison for u^T vs y
- Progress since last year
- Why move from PN to NR era?
  - How is consistency shown?
- What is the NR-PN route?
- What can we expect for waveforms?

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Form of the PN expansion

$$u^T = u^T_{\rm Schw} + q\, u^T_{\rm SF} + q^2\, u^T_{\rm PSF} + \mathcal{O}(q^3)$$

$$u^T_{\rm SF}(y) = -y - 2y^2 - 5y^3 + \left(-\frac{121}{3} + \frac{41}{32}\pi^2\right) y^4 + \left(\alpha_4 - \frac{64}{5}\ln y\right) y^5 + \left(\alpha_5 + \frac{956}{105}\ln y\right) y^6 + o(y^6)$$

$$u^T_{\rm PSF}(y) = y + 3y^2 + \frac{97}{8}y^3 + \left(\frac{725}{12} - \frac{41}{64}\pi^2\right) y^4 + \epsilon_4\, y^5 + \left(\epsilon_5 + \frac{4588}{35}\ln y\right) y^6 + o(y^6)$$

Progress since last year

- Calculate 3 known PN coefficients
  - evaluation of error estimates
  - check using PN exact results
- Calculate several unknown coefficients
  - heavily dependent on improved data
  - limited scope for further improvement

Calculating known PN coefficients

3PN coeff.	Ref. [?]	Paper I	Paper II	PN (exact)
a_3	$-32.34(6)$	$-32.479(10)$	$-32.5008069(7)$	$-32.50080538\cdots$
α_3	$-27.61(3)$	$-27.677(5)$	$-27.6879035(4)$	$-27.68790269\cdots$

- results rely strongly on other PN input

coeff.	estimate	accuracy	exact result
α_3	$-27.677(5)$	$\rightarrow (11)$	-27.6879
a_3	$-32.5008069(7)$	$\rightarrow (15)$	-32.50080538
b_4	$-25.612(2)$	$\rightarrow (12)$	-25.6
b_5	$+55.7(2)$	$\rightarrow (9)$	$+56.6095$

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New PN coefficients

coeff.	value	coeff.	value
a_4	$-121.30310(10)$	α_4	$-114.34747(5)$
a_5	$-42.89(2)$	α_5	$-245.53(1)$
a_6	$-215(4)$	α_6	$-695(2)$
b_6	$+680(1)$	β_6	$+339.3(5)$
a_7	$-8279(25)$	α_7	$-5837(16)$

- Limited by finite set and range of data

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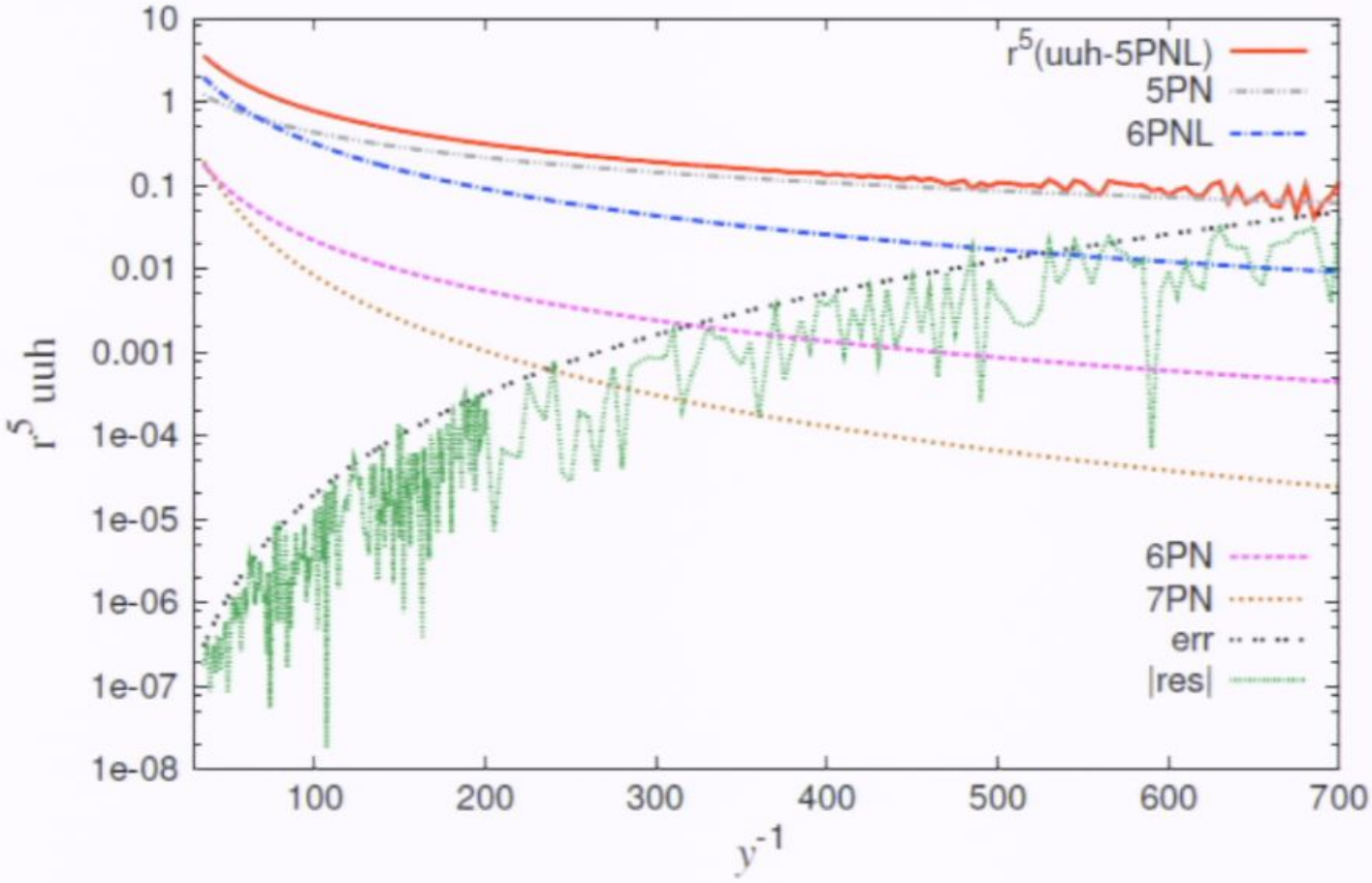
How limitations arise



Move from PN to NR era

- What is required for evolution?
- First need to compare descriptions
  - Evaluate known PN coefficient numerically
- Predict unknown PN coefficients numerically
  - Can we refine PN waveform description?
- Error estimation an essential ingredient

The PN-NR route

- PN can tell us when 2nd order is needed
- Best way to improve evolution is by improving PN numerically
- Probably need to go beyond PN, as in EOB
- Very similar problem for both SF and NR
- Will the same solutions apply to both?