The Astrophysical Journal, 824:62 (2pp), 2016 June 10 doi:10.3847/0004-637X/824/1/62

ERRATUM: "BLACK HOLE–NEUTRON STAR MERGERS WITH A HOT NUCLEAR EQUATION OF STATE: OUTFLOW AND NEUTRINO-COOLED DISK FOR A LOW-MASS, HIGH-SPIN CASE" (2013, ApJ, 776, 47)

M. Brett Deaton[1], Matthew D. Duez[1], Francois Foucart[2], Evan O'Connor[2], Christian D. Ott[3], Lawrence E. Kidder[4], Curran D. Muhlberger[4], Mark A. Scheel[3], and Bela Szilagyi[3]

[1] Department of Physics & Astronomy, Washington State University, Pullman, Washington 99164, USA; mbdeaton@wsu.edu, m.duez@wsu.edu
[2] Canadian Institute for Theoretical Astrophysics, University of Toronto, Toronto, Ontario M5S 3H8, Canada
[3] TAPIR, MC 350-17, California Institute of Technology, Pasadena, California 91125, USA
[4] Center for Radiophysics and Space Research, Cornell University, Ithaca, New York, 14853, USA
Received 2016 April 21; accepted 2016 May 2; published 2016 June 13

ERROR IN R_{ν_i}

We recently discovered an error in the leakage calculations which incorrectly used `log10` instead of `log` in the analytic form of the zeroth-order Fermi integral. The integral was used to compute number loss rates in the diffusive regime, as in Equation (A34) in Rosswog & Liebendörfer (2003). The effect of the error was to artificially suppress neutrino number emission rates, R_{ν_i}, in the optically thick regions of the simulations by a factor of approximately $\log_{10} e \sim 0.5$. It had no direct effect on the energy emission rates, Q_{ν_i}. Below we estimate the effect of our error on the average electron fraction, $\langle Y_e \rangle$, and average neutrino energies, $\langle E_{\nu_i} \rangle$.

EFFECT ON $\langle Y_e \rangle$

From comparisons of a disk simulation (different from this one, but also experiencing significant diffusive neutrino losses) computed with and without the error, we conclude that $\langle Y_e \rangle$ was not significantly affected. This is expected. For most of its life the disk is in a quasi-equilibrium state with respect to the charged-current reactions. In this regime the timescale for a local change in Y_e (set by $R_{\nu_e} - R_{\bar{\nu}_e}$) is much shorter than for changes in density and temperature. A small difference in the rate of change of Y_e does not effect this hierarchy of timescales, and the disk's $\langle Y_e \rangle$ is simply set by its density and temperature. For further description of this comparison see Foucart et al. (2016, Section II.C).

In addition, the neutrino-driven evolution of the dynamical outflows was dominated by free-streaming neutrino losses, so that the effect of the error was negligible also on our estimate of the ejecta $\langle Y_e \rangle$.

EFFECT ON $\langle E_{\nu_i} \rangle$

The only significant effect of this error on our findings was that our estimates of the average neutrino energies were artificially high. This is because the total number-averaged energies were calculated from $\langle E_{\nu_i} \rangle \equiv \int d^3x\, Q_{\nu_i} \Big/ \int d^3x\, R_{\nu_i}$, and the error suppressed R_{ν_i} by a factor of 2 (at most) while leaving Q_{ν_i} unchanged.

Here we recalculate the neutrino energies at several times late in the simulation. Figure 1 corrects the bottom panel of Figure 12 from the published version of this paper. The sentence interpreting that figure on p. 13 should now read: "The average energy per neutrino, given by L_{ν_i}/R_{ν_i}, averaged in time over the disk evolution is about 7, 9, and 14 MeV for ν_e, $\bar{\nu}_e$, and ν_x neutrinos, respectively;

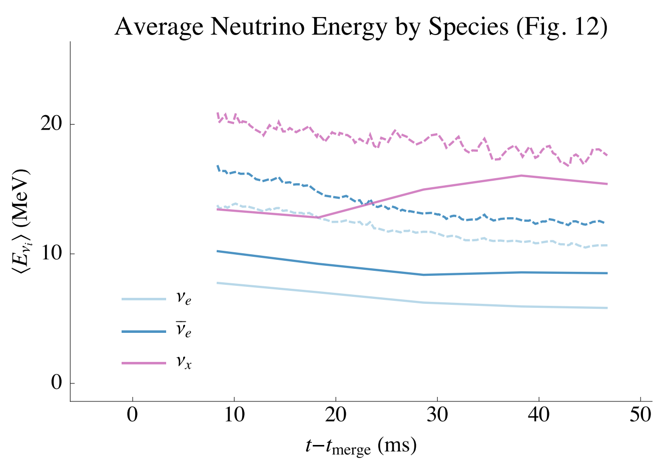

Figure 1. Average neutrino energies for each species. The dashed lines are reproduced from the last 40 ms of the bottom panel of Figure 12 of the published version of this paper; the solid lines are the corrected estimates. Note that as the disk cools the boundary separating the regions in which neutrinos diffuse from those in which they freely escape encloses less and less of the matter, and the effect of the error on the average neutrino energies becomes less and less significant. This is especially pronounced for ν_x, for which the erroneous energy estimates almost agree with the corrected estimates by the end of the simulation.

the average neutrino energies are not constant, but decrease for ν_e and $\bar{\nu}_e$ at a rate of about 0.5 MeV per 10 ms. The brief increase in $\langle E_{\nu_x} \rangle$ is a transient effect of the transition of that species' emission from an epoch dominated by diffusion to one dominated by free-streaming."

CONCLUSION

This code error led us to report average neutrino energies that were erroneously high for a leakage model. See Figure 1 for a correction. It had an insignificant effect on the hydrodynamics and composition evolution.

REFERENCES

Foucart, F., Haas, R., Duez, M. D., et al. 2016, PhRD, 93, 044019
Rosswog, S., & Liebendörfer, M. 2003, MNRAS, 342, 673