Erratum: Testing the newborn pulsar origin of ultrahigh energy cosmic rays with EeV neutrinos
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We noticed an error in the calculation of Eq. (1) in Ref. [1]. While the equation shown is correct, the redshift dependence of source spectra was not properly taken into account. The all-flavor neutrino flux from the pulsar population can be calculated as

$$\Phi_\nu = \frac{dN}{dEdAdtd\Omega} = \frac{f_s}{4\pi} \int_0^{z_{\max}} \int_0^{t_\nu} \frac{dN_\nu}{dt'dE_\nu 4\pi D^2} dt' \mathfrak{R}(z) 4\pi D^2 \frac{dD}{dz} dz, \quad (1)$$

which can be further written as below to show the redshift dependence explicitly:

$$\Phi_\nu = \frac{c}{4\pi} \int_0^{z_{\max}} \mathfrak{R}(z) \frac{dN[E(1+z)]}{dE'} (1+z) \frac{dt}{dz} dz, \quad (2)$$

where $dN/dE' = f_s \int dP_i dB dN/dE'(P_i, B) f(P_i, B)$ is the expected spectrum from one pulsar at redshift z , which is averaged over the pulsar distribution $f(P_i, B)$ of initial spin periods P_i and surface magnetic fields B , and normalized by a factor f_s determined by ultrahigh energy cosmic ray (UHECR) observations; $E' = (1+z)E$ is the redshifted energy at the source, and $dt/dz = 1/(H_0(1+z)\sqrt{\Omega_M(1+z)^3 + \Omega_\Lambda})$. We take the Hubble constant $h = 67.8$, $\Omega_M = 0.308$ [2], and assume a flat Universe in this calculation. $\mathfrak{R}(z)$ is the source emissivity in units of $\text{Mpc}^{-3} \text{yr}^{-1}$, and can be written as $\mathfrak{R}(z) = g(z)\mathfrak{R}(0)$, with $g(z)$ denoting the source evolution rate over redshift. If the source emissivity follows a uniform distribution, $g(z) = 1$. Alternatively, if the source evolution follows the star formation rate, $g(z)$ can be written as [3]

FIG. 1 (color online). The diffuse neutrino flux ($\nu_\mu + \nu_e + \nu_\tau$ after neutrino mixing in space) from an extragalactic newborn pulsar population that would produce the measured UHECRs. The source emissivity follows the SFR (blue) or is uniform over time (black). Overlaid are all flavor neutrino flux sensitivities of the IceCube detector after 1 year (red thin dash) and 5 years (red thick dash) of operations [4], and the expected 3 year ARA-37 sensitivities (orange dash dotted) [5]. The redshift dependence of source spectra has been taken into account to follow Eq. (2).

$$g(z) = \begin{cases} (1+z)^{3.4}, & z < 1, \\ N_1(1+z)^{-0.3}, & 1 < z < 4, \\ N_1 N_4(1+z)^{-3.5}, & z > 4, \end{cases} \quad (3)$$

with the normalization factors $N_1 = 2^{3.7}$ and $N_2 = 5^{3.2}$.

Figure 1 shows the corrected diffusive neutrino flux from the fast-spinning newborn pulsars. The shapes of the neutrino spectra are unchanged. The flux is slightly smaller than the Waxman-Bahcall landmark and the prediction of the fast-spinning magnetar model. This is because efficient neutrino production occurs only in a fraction of fast-spinning pulsars and most pulsars can release cosmic-ray nuclei without depletion by meson production.

After the correction, the neutrino flux peak at around $10^{17.5}$ eV is found to be comparable to the IceCube 5-year sensitivity [4] in the SFR case, and to the 3-year ARA sensitivity [5] in the uniform case. The conclusion that the model is testable in the future remains unchanged.

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