CONVERGENCE OF A NEW TRIVARIATE MITTAG-LEFFLER-TYPE FUNCTION

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Abstract

This paper introduces a new trivariate Mittag-Leffler type function and investigates its fundamental properties. The regions of convergence of the triple power series are established, an integral representation is derived, and corresponding estimates are obtained. The convergence analysis is carried out using Horn's method, supported by the asymptotic behavior of the gamma function for large arguments. Six distinct cases are examined depending on various combinations of the parameters, and in each case the conditions for absolute convergence of the series are determined. The results obtained are relevant to the theory of fractional differential equations, particularly for problems involving the Prabhakar fractional derivative.

Key words: *Mittag-Leffler function, trivariate function, fractional calculus, Prabhakar derivative, triple power series, region of convergence, gamma function, integral representation, special functions, fractional differential equations.*

In this subsection [2], we introduce a new trivariate Mittag-Leffler type function and study its main properties [1-3]. Namely, we determine regions of convergence of double series, integral representation, and estimate

$$ {}_3E_1\left(\begin{matrix}\alpha_1,\delta_1,\mu_1,\sigma_1;\alpha_2,\delta_2,\sigma_2;\\ \alpha_3,\delta_3,\mu_2,\sigma_3;\alpha_4,\delta_4,\sigma_4;\alpha_5,\sigma_5;\delta_5,\sigma_6;\mu_3,\sigma_7;\end{matrix}\middle| x;y;z\right)= $$

$$ =\sum_{m,j,k=0}^{+\infty}\frac{\Gamma\left(\alpha_1 m+\delta_1 j+\mu_1 k+\sigma_1\right)\Gamma\left(\alpha_2 m+\delta_2 j+\sigma_2\right)}{\Gamma\left(\alpha_3 m+\delta_3 j+\mu_2 k+\sigma_3\right)\Gamma\left(\alpha_4 m+\delta_4 j+\sigma_4\right)}\times $$

$$ \times\frac{x^m y^j z^k}{\Gamma\left(\alpha_5 m+\sigma_5\right)\Gamma\left(\delta_5 j+\sigma_6\right)\Gamma\left(\mu_3 k+\sigma_7\right)}, \qquad (1) $$

$\left(x,y,z,\alpha_l,\delta_l,\mu_i,\sigma_n\in\mathbb{C};\ \min\left\{\alpha_l,\delta_l,\mu_i,\sigma_n\right\}>0,\left(l=\overline{1,5},\ i=\overline{1,3},\ n=\overline{1,7}\right)\right)$ in which the triple series converges for $x,y,z\in\mathbb{C}$, if $\Delta_1>0$, $\Delta_2>0$ and $\Delta_3>0$.

Here

$$ \Delta_1=\alpha_3+\alpha_4+\alpha_5-\alpha_1-\alpha_2,\ \Delta_2=\delta_3+\delta_4+\delta_5-\delta_1-\delta_2,\ \Delta_3=\mu_2+\mu_3-\mu_1. $$

The triple series in (1) converges absolutely for $|x|<\rho_1$, $|y|<\rho_2$ and $|z|<\rho_3$, if $\Delta_1=0$, $\Delta_2=0$, $\Delta_3=0$ as described in

$$ \rho_1=\min_{\eta,\nu,\xi>0}\left(E_1\right),\ \rho_2=\min_{\eta,\nu,\xi>0}\left(E_2\right),\ \rho_3=\min_{\eta,\nu,\xi>0}\left(E_3\right),\ \eta,\nu,\xi>0 $$

and

$$ E_1=\eta^{\alpha_5}\frac{\left(\alpha_3\eta+\delta_3\nu+\mu_2\xi\right)^{\alpha_3}\left(\alpha_4\eta+\delta_4\nu\right)^{\alpha_4}\left(\alpha_5\right)^{\alpha_5}}{\left(\alpha_1\eta+\delta_1\nu+\mu_1\xi\right)^{\alpha_1}\left(\alpha_2\eta+\delta_2\nu\right)^{\alpha_2}}, $$

$$ E_2=\nu^{\delta_5}\frac{\left(\alpha_3\eta+\delta_3\nu+\mu_2\xi\right)^{\delta_3}\left(\alpha_4\eta+\delta_4\nu\right)^{\delta_4}\left(\delta_5\right)^{\delta_5}}{\left(\alpha_1\eta+\delta_1\nu+\mu_1\xi\right)^{\delta_1}\left(\alpha_2\eta+\delta_2\nu\right)^{\delta_2}}, $$

$$E_3=\xi^{\mu_3}\frac{\left(\alpha_3\eta+\delta_3\nu+\mu_2\xi\right)^{\mu_2}\left(\mu_3\right)^{\mu_3}}{\left(\alpha_1\eta+\delta_1\nu+\mu_1\xi\right)^{\mu_1}},$$

respectively.

Proof (Regions of convergence). Based on Horn’s work [5], we identify the region of convergence for the trivariate Mittag-Leffler type function ${}_3E_1(.)$.

Let us denote the following expression in by $A(m,j,k)$:

$$A(m,j,k)=\frac{\Gamma\left(\alpha_1m+\delta_1j+\mu_1k+\sigma_1\right)\Gamma\left(\alpha_2m+\delta_2j+\sigma_2\right)}{\Gamma\left(\alpha_3m+\delta_3j+\mu_2k+\sigma_3\right)\Gamma\left(\alpha_4m+\delta_4j+\sigma_4\right)}\times$$
$$\times\frac{1}{\Gamma\left(\alpha_5m+\sigma_5\right)\Gamma\left(\delta_5j+\sigma_6\right)\Gamma\left(\mu_3k+\sigma_7\right)},\qquad(2)$$

We introduce the following notations:

$$f_1(m,j,k)=\frac{A(m+1,j,k)}{A(m,j,k)},\quad f_2(m,j,k)=\frac{A(m,j+1,k)}{A(m,j,k)},$$
$$f_3(m,j,k)=\frac{A(m,j,k+1)}{A(m,j,k)}.\qquad(3)$$

Using the notations, we obtain $f_1(m,j,k)$, $f_2(m,j,k)$ and $f_3(m,j,k)$:

$$f_1(m,j,k)=\frac{\Gamma\left(\alpha_1m+\delta_1j+\mu_1k+\sigma_1+\alpha_1\right)\Gamma\left(\alpha_2m+\delta_2j+\sigma_2+\alpha_2\right)}{\Gamma\left(\alpha_3m+\delta_3j+\mu_2k+\sigma_3+\alpha_3\right)\Gamma\left(\alpha_4m+\delta_4j+\sigma_4+\alpha_4\right)}\times$$
$$\times\frac{1}{\Gamma\left(\alpha_5m+\sigma_5+\alpha_5\right)\Gamma\left(\delta_5j+\sigma_6\right)\Gamma\left(\mu_3k+\sigma_7\right)}\times$$
$$\times\frac{\Gamma\left(\alpha_3m+\delta_3j+\mu_2k+\sigma_3\right)\Gamma\left(\alpha_4m+\delta_4j+\sigma_4\right)}{\Gamma\left(\alpha_1m+\delta_1j+\mu_1k+\sigma_1\right)\Gamma\left(\alpha_2m+\delta_2j+\sigma_2\right)}\times$$
$$\times\Gamma\left(\alpha_5m+\sigma_5\right)\Gamma\left(\delta_5j+\sigma_6\right)\Gamma\left(\mu_3k+\sigma_7\right)=$$
$$=\frac{\Gamma\left(\alpha_1m+\delta_1j+\mu_1k+\sigma_1+\alpha_1\right)\Gamma\left(\alpha_2m+\delta_2j+\sigma_2+\alpha_2\right)}{\Gamma\left(\alpha_1m+\delta_1j+\mu_1k+\sigma_1\right)\Gamma\left(\alpha_2m+\delta_2j+\sigma_2\right)}\times$$
$$\times\frac{\Gamma\left(\alpha_3m+\delta_3j+\mu_2k+\sigma_3\right)\Gamma\left(\alpha_4m+\delta_4j+\sigma_4\right)\Gamma\left(\alpha_5m+\sigma_5\right)}{\Gamma\left(\alpha_3m+\delta_3j+\mu_2k+\sigma_3+\alpha_3\right)\Gamma\left(\alpha_4m+\delta_4j+\sigma_4+\alpha_4\right)\Gamma\left(\alpha_5m+\sigma_5+\alpha_5\right)},$$

similarly, we define

$$f_2(m,j,k)=\frac{\Gamma\left(\alpha_1m+\delta_1j+\mu_1k+\sigma_1+\delta_1\right)\Gamma\left(\alpha_2m+\delta_2j+\sigma_2+\delta_2\right)}{\Gamma\left(\alpha_3m+\delta_3j+\mu_2k+\sigma_3+\delta_3\right)\Gamma\left(\alpha_4m+\delta_4j+\sigma_4+\delta_4\right)}\times$$
$$\times\frac{1}{\Gamma\left(\alpha_5m+\sigma_5\right)\Gamma\left(\delta_5j+\sigma_6+\delta_5\right)\Gamma\left(\mu_3k+\sigma_7\right)}\times$$
$$\times\frac{\Gamma\left(\alpha_3m+\delta_3j+\mu_2k+\sigma_3\right)\Gamma\left(\alpha_4m+\delta_4j+\sigma_4\right)}{\Gamma\left(\alpha_1m+\delta_1j+\mu_1k+\sigma_1\right)\Gamma\left(\alpha_2m+\delta_2j+\sigma_2\right)}\times$$
$$\times\Gamma\left(\alpha_5m+\sigma_5\right)\Gamma\left(\delta_5j+\sigma_6\right)\Gamma\left(\mu_3k+\sigma_7\right)=$$

$$=\frac{\Gamma\left(\alpha_1 m+\delta_1 j+\mu_1 k+\sigma_1+\delta_1\right)\Gamma\left(\alpha_2 m+\delta_2 j+\sigma_2+\delta_2\right)}{\Gamma\left(\alpha_1 m+\delta_1 j+\mu_1 k+\sigma_1\right)\Gamma\left(\alpha_2 m+\delta_2 j+\sigma_2\right)}\times$$

$$\times\frac{\Gamma\left(\alpha_3 m+\delta_3 j+\mu_2 k+\sigma_3\right)\Gamma\left(\alpha_4 m+\delta_4 j+\sigma_4\right)\Gamma\left(\delta_5 j+\sigma_6\right)}{\Gamma\left(\alpha_3 m+\delta_3 j+\mu_2 k+\sigma_3+\delta_3\right)\Gamma\left(\alpha_4 m+\delta_4 j+\sigma_4+\delta_4\right)\Gamma\left(\delta_5 j+\sigma_6+\delta_5\right)},$$

in the same manner

$$f_3(m,j,k)=\frac{\Gamma\left(\alpha_1 m+\delta_1 j+\mu_1 k+\sigma_1+\mu_1\right)\Gamma\left(\alpha_2 m+\delta_2 j+\sigma_2\right)}{\Gamma\left(\alpha_3 m+\delta_3 j+\mu_2 k+\sigma_3+\mu_2\right)\Gamma\left(\alpha_4 m+\delta_4 j+\sigma_4\right)}\times$$

$$\times\frac{1}{\Gamma\left(\alpha_5 m+\sigma_5\right)\Gamma\left(\delta_5 j+\sigma_6\right)\Gamma\left(\mu_3 k+\sigma_7+\mu_3\right)}\times$$

$$\times\frac{\Gamma\left(\alpha_3 m+\delta_3 j+\mu_2 k+\sigma_3\right)\Gamma\left(\alpha_4 m+\delta_4 j+\sigma_4\right)}{\Gamma\left(\alpha_1 m+\delta_1 j+\mu_1 k+\sigma_1\right)\Gamma\left(\alpha_2 m+\delta_2 j+\sigma_2\right)}\times$$

$$\times\Gamma\left(\alpha_5 m+\sigma_5\right)\Gamma\left(\delta_5 j+\sigma_6\right)\Gamma\left(\mu_3 k+\sigma_7\right)=$$

$$=\frac{\Gamma\left(\alpha_1 m+\delta_1 j+\mu_1 k+\sigma_1+\mu_1\right)\Gamma\left(\alpha_3 m+\delta_3 j+\mu_2 k+\sigma_3\right)\Gamma\left(\mu_3 k+\sigma_7\right)}{\Gamma\left(\alpha_1 m+\delta_1 j+\mu_1 k+\sigma_1\right)\Gamma\left(\alpha_3 m+\delta_3 j+\mu_2 k+\sigma_3+\mu_2\right)\Gamma\left(\mu_3 k+\sigma_7+\mu_3\right)}.$$

Then, we have

$$f_1(\eta t,\nu t,\xi t)=\frac{\Gamma\left(\alpha_1\eta t+\delta_1\nu t+\mu_1\xi t+\sigma_1+\alpha_1\right)\Gamma\left(\alpha_2\eta t+\delta_2\nu t+\sigma_2+\alpha_2\right)}{\Gamma\left(\alpha_1\eta t+\delta_1\nu t+\mu_1\xi t+\sigma_1\right)\Gamma\left(\alpha_2\eta t+\delta_2\nu t+\sigma_2\right)}\times$$

$$\times\frac{\Gamma\left(\alpha_3\eta t+\delta_3\nu t+\mu_2\xi t+\sigma_3\right)\Gamma\left(\alpha_4\eta t+\delta_4\nu t+\sigma_4\right)\Gamma\left(\alpha_5\eta t+\sigma_5\right)}{\Gamma\left(\alpha_3\eta t+\delta_3\nu t+\mu_2\xi t+\sigma_3+\alpha_3\right)\Gamma\left(\alpha_4\eta t+\delta_4\nu t+\sigma_4+\alpha_4\right)\Gamma\left(\alpha_5\eta t+\sigma_5+\alpha_5\right)},$$

$$f_2(\eta t,\nu t,\xi t)=\frac{\Gamma\left(\alpha_1\eta t+\delta_1\nu t+\mu_1\xi t+\sigma_1+\delta_1\right)\Gamma\left(\alpha_2\eta t+\delta_2\nu t+\sigma_2+\delta_2\right)}{\Gamma\left(\alpha_1\eta t+\delta_1\nu t+\mu_1\xi t+\sigma_1\right)\Gamma\left(\alpha_2\eta t+\delta_2\nu t+\sigma_2\right)}\times$$

$$\times\frac{\Gamma\left(\alpha_3\eta t+\delta_3\nu t+\mu_2\xi t+\sigma_3\right)\Gamma\left(\alpha_4\eta t+\delta_4\nu t+\sigma_4\right)\Gamma\left(\delta_5\nu t+\sigma_6\right)}{\Gamma\left(\alpha_3\eta t+\delta_3\nu t+\mu_2\xi t+\sigma_3+\delta_3\right)\Gamma\left(\alpha_4\eta t+\delta_4\nu t+\sigma_4+\delta_4\right)\Gamma\left(\delta_5\nu t+\sigma_6+\delta_5\right)},$$

$$f_3(\eta t,\nu t,\xi t)=\frac{\Gamma\left(\alpha_1\eta t+\delta_1\nu t+\mu_1\xi t+\sigma_1+\mu_1\right)\Gamma\left(\alpha_3\eta t+\delta_3\nu t+\mu_2\xi t+\sigma_3\right)\Gamma\left(\mu_3\xi t+\sigma_7\right)}{\Gamma\left(\alpha_1\eta t+\delta_1\nu t+\mu_1\xi t+\sigma_1\right)\Gamma\left(\alpha_3\eta t+\delta_3\nu t+\mu_2\xi t+\sigma_3+\mu_2\right)\Gamma\left(\mu_3\xi t+\sigma_7+\mu_3\right)}.$$

Based on the asymptotic behavior of the Gamma function for large arguments [4],

$$\frac{\Gamma(z+\alpha)}{\Gamma(z+\beta)}\sim z^{\alpha-\beta}\left[1+\frac{(\alpha-\beta)(\alpha+\beta-1)}{2z}+O\left(z^{-2}\right)\right],\quad |\arg(z)|\le\pi,$$

we obtain

$$f_1(\eta t,\nu t,\xi t)\to t^{\alpha_1+\alpha_2-\alpha_3-\alpha_4-\alpha_5}\frac{\left(\alpha_1\eta+\delta_1\nu+\mu_1\xi\right)^{\alpha_1}\left(\alpha_2\eta+\delta_2\nu\right)^{\alpha_2}}{\left(\alpha_3\eta+\delta_3\nu+\mu_2\xi\right)^{\alpha_3}\left(\alpha_4\eta+\delta_4\nu\right)^{\alpha_4}\left(\alpha_5\eta\right)^{\alpha_5}},$$

$$f_1(\eta t,\nu t,\xi t)\sim\frac{1}{E_1}t^{-\Delta_1},\ \Delta_1=\alpha_3+\alpha_4+\alpha_5-\alpha_1-\alpha_2, \tag{4}$$

$$E_1=\eta^{\alpha_5}\frac{\left(\alpha_3\eta+\delta_3\nu+\mu_2\xi\right)^{\alpha_3}\left(\alpha_4\eta+\delta_4\nu\right)^{\alpha_4}\left(\alpha_5\right)^{\alpha_5}}{\left(\alpha_1\eta+\delta_1\nu+\mu_1\xi\right)^{\alpha_1}\left(\alpha_2\eta+\delta_2\nu\right)^{\alpha_2}},\ G_1=\frac{\left(\alpha_3\right)^{\alpha_3}\left(\alpha_4\right)^{\alpha_4}\left(\alpha_5\right)^{\alpha_5}}{\left(\alpha_1\right)^{\alpha_1}\left(\alpha_2\right)^{\alpha_2}},$$

likewise we define

$$f_2(\eta t,\nu t,\xi t)\to t^{\delta_1+\delta_2-\delta_3-\delta_4-\delta_5}\frac{(\alpha_1\eta+\delta_1\nu+\mu_1\xi)^{\delta_1}(\alpha_2\eta+\delta_2\nu)^{\delta_2}}{(\alpha_3\eta+\delta_3\nu+\mu_2\xi)^{\delta_3}(\alpha_4\eta+\delta_4\nu)^{\alpha_4}(\delta_5\nu)^{\delta_5}},$$

$$f_2(\eta t,\nu t,\xi t)\square\frac{1}{E_2}t^{-\Delta_2},\qquad \Delta_2=\delta_3+\delta_4+\delta_5-\delta_1-\delta_2, \tag{5}$$

$$E_2=\nu^{\delta_5}\frac{(\alpha_3\eta+\delta_3\nu+\mu_2\xi)^{\delta_3}(\alpha_4\eta+\delta_4\nu)^{\alpha_4}(\delta_5)^{\delta_5}}{(\alpha_1\eta+\delta_1\nu+\mu_1\xi)^{\delta_1}(\alpha_2\eta+\delta_2\nu)^{\delta_2}},\ G_2=\frac{(\delta_3\nu)^{\delta_3}(\delta_4)^{\alpha_4}(\delta_5)^{\delta_5}}{(\delta_1)^{\delta_1}(\delta_2)^{\delta_2}},$$

analogously, we define

$$f_3(\eta t,\nu t,\xi t)\to t^{\mu_1-\mu_2-\mu_3}\frac{(\alpha_1\eta+\delta_1\nu+\mu_1\xi)^{\mu_1}}{(\alpha_3\eta+\delta_3\nu+\mu_2\xi)^{\mu_2}(\mu_3\xi)^{\mu_3}},$$

$$f_3(\eta t,\nu t,\xi t)\square\frac{1}{E_3}t^{-\Delta_3},\ \Delta_3=\mu_2+\mu_3-\mu_1, \tag{6}$$

$$E_3=\xi^{\mu_3}\frac{(\alpha_3\eta+\delta_3\nu+\mu_2\xi)^{\mu_2}(\mu_3)^{\mu_3}}{(\alpha_1\eta+\delta_1\nu+\mu_1\xi)^{\mu_1}},\quad G_3=\frac{(\mu_2)^{\mu_2}(\mu_3)^{\mu_3}}{(\mu_1)^{\mu_1}}.$$

Now, let us consider several cases:

Case 1. Let $\Delta_1>0$, $\Delta_2>0$, $\Delta_3>0$. Using equations (3), (4), (5), and (6), we obtain that

$$\phi_1(\eta,\nu,\xi)=\lim_{t\to\infty}f_1(\eta t,\nu t,\xi t)=0,\ \phi_2(\eta,\nu,\xi)=\lim_{t\to\infty}f_2(\eta t,\nu t,\xi t)=0,$$
$$\phi_3(\eta,\nu,\xi)=\lim_{t\to\infty}f_3(\eta t,\nu t,\xi t)=0.$$

Both ρ_1,ρ_2 and ρ_3. These are large positive numbers, while the series remains convergent for any argument value.

Case 2. Let $\Delta_1=0,\ \Delta_2=0,\ \Delta_3=0$. It follows from equations (3), (4), (5), and (6) that

$$\phi_1(\eta,\nu,\xi)=\frac{1}{E_1},\ \phi_2(\eta,\nu,\xi)=\frac{1}{E_2},\ \phi_3(\eta,\nu,\xi)=\frac{1}{E_3},$$

which yields the parametric form of curve C shown in the (ρ_1,ρ_2,ρ_3) - plane as $\rho_1=G_1,\rho_2=G_2$ and $\rho_3=G_3$. Hence, absolute convergence of the series is ensured for $|x|<\rho_1,\ |y|<\rho_2$ and $|z|<\rho_3$, with $\rho_1=\min_{(\eta,\nu,\xi)}(E_1),\ \rho_2=\min_{(\eta,\nu,\xi)}(E_2)$ and $\rho_3=\min_{(\eta,\nu,\xi)}(E_3)$.

Case 3. Let $\Delta_1<0,\ \Delta_2<0$ and $\Delta_3<0$. The series diverges for $\rho_1=\rho_2=\rho_3=0$. Convergence of the series occurs exclusively at the point $x=y=z=0$.

Case 4. Assume that $\Delta_1=0,\ \Delta_2>0$ and $\Delta_3>0$. The series converges uniquely at the point $|x|<\rho_1,\ |y|<\infty$ and $|z|<\infty$.

Case 5. Suppose that $\Delta_1>0,\ \Delta_2=0$ and $\Delta_3=0$. The series is convergent solely at the point $|x|<\infty,\ |y|<\rho_2$ and $|z|<\infty$.

Case 6. Let $\Delta_1>0,\ \Delta_2>0$ and $\Delta_3=0$. Thus, the series converges the absolutely in the domain where $|x|<\infty,\ |y|<\infty$ and $|z|<\rho_3$.

REFERENCES:

1. Karimov, E.T., & Hasanov, A. (2023). On a boundary-value problem in a bounded domain for a time-fractional diffusion equation with the Prabhakar fractional derivative. *Bulletin of the Karaganda University. Mathematics Series, 111*(3), 39–46.

2. A. Rafiqov and E. Tursunova (2025), The Cauchy problem for a differential equation with several Prabhakar fractional derivatives, *Bull. Inst. Math.* 8 (6), 178–184. **http://mib.mathinst.uz**

3. Prabhakar, T.R. (1971). A singular integral equation with a generalized Mittag-Leffler function in the kernel. *Yokohama Math. J., 19,* 7–15.

4. Luke L.Y. The Special Functions and Their Approximations. - Academic Press: New York-London, 1969.

5. Horn J. Uber die konvergenz der hypergeometrischen Reihen zweier und dreier Veranderliehen// Mathematische Annalen, 1889.- Vol.34.-P.544-600.

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