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# HELMHOLTZ'S EQUATION ON A CUBED SPHERE

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This work solves Helmholtz equation on a cubed sphere defined by Nasir (2007) and studies symmetric properties of the solutions. A partial differential equation of the form $\nabla^2 F + k^2 F = 0$, where $\nabla^2$ is the Laplacian, $k$ is the wave number and $F$ is the amplitude is known as the Helmholtz's equation. When $k = 0$, this reduces to Laplace's equation. Both of these equations are two important partial differential equations those arise often in the study of physical problems involving in both space and time. Thus, solving Laplace's equation and Helmholtz's equation have been attempted by researchers under various conditions. Objective of this work is to solve Helmholtz equation on a selected cubed sphere and study its symmetric properties. Helmholtz equation on sphere can be defined as $\Delta_S U - \lambda U = r$, where $\Delta_S U$ is the Laplace-Beltrami operator. For simplicity, we chose $r$ when $\lambda = 1$ such that the analytical solution of the equation has the form $U = (1 + xy)\exp(z)$. We, in an earlier paper, named each face of the cubed sphere as $X^+, Y^+$, $Z^+$, $X^-, Y^-$, $Z^-$ and assigned local coordinates . $t_1$ and $t_2$ for each plane. In this work, we proved, by our trial solution, that $U_{X^+} = U_{X^-}$ and $U_{Y^+} = U_{Y^-}$ and since $\Delta_S$ is symmetric in $t_1$ and $t_2$, solutions of Helmholtz equation on the faces $X^-$ and $Y^-$ have same expressions as those of $X^+$ and $Y^+$respectively. However, solutions on the surfaces $Z^+$ and $Z^-$ are different as $U_{Z^+}, U_{Z^-}$ are not comparable. This is because the $z$ coordinates for $Z^+, Z^-$ surfaces are different even though $xy$ value remains same.

***Keywords:*** *Cubed sphere, Helmholtz equation, Laplace-Beltrami operator.*