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Decay of Dusty Fluid MHD Turbulence for Four-point Correlation in a Rotating System

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Abstract

In this paper we have considered the dusty fluid MHD turbulence in a rotating system at four-point correlation. Here three and four-point correlations between fluctuating quantities have been considered and the quintuple correlations are neglected in comparison to the third and fourth order correlations. For the convention of calculation, the correlation equations are converted to the spectral form by taking their Fourier transforms. Finally, integrating the energy spectrum over all wave numbers, the energy decay of dusty fluid MHD turbulence in a rotating system for four-point correlation system is obtained.

Keywords: MHD turbulence; Dusty fluid; Correlations; Rotating system; Decay law.

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1. Introduction

In recent year, the motion of dusty viscous fluids in a rotating system has developed rapidly. The motion of dusty fluid occurs in the movement of dust –laden air, in problems of fluidization, in the use of dust in a gas cooling system and in the sedimentation problem of tidal rivers. The behavior of dust particles in a turbulent flow depends on the concentrations of the particles and the size of the particles with respect to the scale of turbulent fluid. In geophysical flows, the system is usually rotation with a constant velocity; such large scale flows are generally turbulent. The Coriolis Effect strongly affects the large-scale Oceanic, Atmospheric circulation, streams, western boundary currents, geotropic balance, Rossby waves, Kelvin waves, external ballistics for calculating the trajectories of very long-range artillery shells. The Coriolis effects has great significance in Astrophysics and Stellar dynamics. It is also significant in the Earth sciences, especially Meteorology, Physical geology and Oceanography. Kishore and Golsefid [1] obtained and expression for the effect of Coriolis force on acceleration covariance in MHD turbulent flow of a dusty incompressible fluid. Shimomura and

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Yoshizawa [2] derived expressions for statistical analysis of an isotropic turbulent viscosity in a rotating system. Shimomura [3] also studied a statistical derived two-equation model of turbulent scalar flux in a rotating system. Chandrasekhar [4] obtained the invariant theory of isotropic turbulence in magneto-hydrodynamics. Kishore and Singh [5] considered the effect of Coriolis force on acceleration covariance in turbulent flow with rotational symmetry. Sarker and Kishore [6] studied the decay of MHD turbulence before the final period. Sarker and Islam [7] obtained the decay of dusty fluid MHD turbulence before the final period in a rotating system. Sarker and Ahmed [8] pointed out that the fiber motion in dusty fluid turbulent flow with two point correlation. Dixit and Upadhyay [9] obtained the effect of Coriolis force on acceleration covariance in MHD turbulent dusty flow with rotational symmetry. Azad *et al*. [10] studied the statistical theory of certain distribution functions in MHD turbulent flow for velocity and concentration undergoing a first order reaction in a rotating system. Islam and Sarker [11] studied the first order reactant in MHD turbulence before the final period of decay for the case of multi-point and multi-time. Azad and Sarker [12] obtained the decay of dusty fluid MHD turbulence before the final period in a rotating system for the case of multi-point and multi-time. Mondal [13] studied the decay of dusty fluid turbulence before the final period in a rotating system. Azad *et al.* [14] studied the first order reactant in MHD turbulence before the final period of decay in a rotating system. Rahman [15] obtained the decay of first order reactant in incompressible MHD turbulence before the final period for the case of multi-point and multi- time in a rotating system.

Deissler [16, 17] developed a theory 'on the decay of homogeneous turbulence before the final period'. By analyzing the above theories we have studied the decay of dusty MHD fluid turbulence in a rotating system for four-point correlation. We have considered two, three and four-point correlation equations after neglecting the quintuple correlations in comparison to the third and fourth order correlation terms. Finally we have obtained the decay of dusty fluid MHD turbulence for four-point correlation in a rotating system.

2. Basic Equations

The equation of motion and continuity for viscous, incompressible MHD dusty fluid turbulent flow are given by [7] as

$$\frac{\partial u_i}{\partial t}+\frac{\partial}{\partial x_k}(u_iu_k-h_ih_k)=-\frac{\partial w}{\partial x_i}+\nu\frac{\partial^2 u_i}{\partial x_k\partial x_k}-2\varepsilon_{\mathrm{pkl}}\Omega_p u_i+f(u_i-v_i)\,, \tag{1}$$

$$\frac{\partial h_i}{\partial t}+\frac{\partial}{\partial x_k}(h_iu_k-u_ih_k)=\frac{\nu}{p_M}\frac{\partial^2 h_i}{\partial x_k\partial x_k}\quad , \tag{2}$$

$$\frac{\partial v_i}{\partial t}+v_k\frac{\partial v_i}{\partial x_k}=-\frac{k}{m_s}(v_i-u_i)\,, \tag{3}$$

with

$$\frac{\partial u_i}{\partial x_i}=\frac{\partial v_i}{\partial x_i}=\frac{\partial h_i}{\partial x_i}=0 \tag{4}$$

3. Mathematical Formulation

To find the four point correlation equation, following Deissler's [17] we take the

momentum equation of dusty fluid MHD turbulence in a rotating system at the point p and the induction equation of magnetic field fluctuation at p', p'' and p''' as

$$\frac{\partial u_l}{\partial t}+u_k\frac{\partial u_l}{\partial x_k}-h_k\frac{\partial h_l}{\partial x_k}=-\frac{\partial w}{\partial x_l}+\nu\frac{\partial^2 u_l}{\partial x_k\partial x_k}-2\varepsilon_{pkl}\Omega_p u_l+f(u_l-v_l) \tag{5}$$

$$\frac{\partial h_i'}{\partial t}+u_k'\frac{\partial h_i'}{\partial x_k'}-h_k'\frac{\partial u_i'}{\partial x_k'}=\frac{\nu}{p_M}\frac{\partial^2 h_i'}{\partial x_k'\partial x_k'}-2\varepsilon_{qki}\Omega_q u_i' \tag{6}$$

$$\frac{\partial h_j''}{\partial t}+u''\frac{\partial h_j''}{\partial x_k''}-h''\frac{\partial u_j''}{\partial x_{k\,k}''}=\frac{\nu}{p_M}\frac{\partial^2 h_j''}{\partial x_k''\partial x_k''}-2\,\varepsilon_{rkj}\Omega_r u_j'' \tag{7}$$

$$\frac{\partial h_m'''}{\partial t}+u_k'''\frac{\partial h_m'''}{\partial x_k'''}-h_k'''\frac{\partial u_m'''}{\partial x_k'''}=\frac{\nu}{p_M}\frac{\partial^2 h_m'''}{\partial x_k'''}-2\,\varepsilon_{skm}\Omega_s u_m''' \tag{8}$$

where $w=\frac{p}{\rho}+\frac{1}{2}\langle h^2\rangle$ is the total MHD pressure, $p(\hat{x},t)$ is the hydrodynamic pressure, ρ is the fluid density, $P_M=\frac{\nu}{\lambda}$ is the Magnetic Prandtl number, Ω_s is the angular velocity components, ε_{skm} is the alternating tensor, $m_i=\frac{4}{3}\pi R^3{}_i\rho_i$ is the mass of a single spherical dust particle of radius R_i and ρ_i constant density of the material in dust particles. $f=\frac{KN}{\rho}$, is the dimensions of frequency, K is the Stock's drug resistance, *N* is the constant number density of dust particle. ν , is the kinematics viscosity, λ is the magnetic diffusivity, $h_i(x,t)$ is the magnetic field fluctuation, $u_k(x,t)$ is the turbulent velocity, v_l dust velocity component, t is the time, x_k is the space co-ordinate and repeated subscripts are summed from 1 to 3.

Multiplying Eq. (5) by $h_i'h_j''h_m'''$ (6) by $u_l h_j''h_m'''$ (7) by $u_l h_i' h_m'''$ (8) by $u_l h_i' h_j''$ and adding the four equations, we than taking the angular bracket $(\overline{\ldots\ldots})$ or $\langle\ldots\ldots\ldots\rangle$, we get

$$\frac{\partial\overline{(u_l h_i'h_j''h_m''')}}{\partial t}+\frac{\partial\overline{(u_l u_k h_i'h_j''h_m''')}}{\partial x_k}-\frac{\partial\overline{(h_k h_l h_i'h_j''h_m''')}}{\partial x_k}+\frac{\partial\overline{(u_l u_k' h_i'h_j''h_m''')}}{\partial x_k'}-\frac{\partial\overline{(u_l u_i' h_k' h_j''h_m''')}}{\partial x_k'}$$
$$+\frac{\partial\overline{(u_l u_k'' h_i'h_j''h''')}}{\partial x_k''}-\frac{\partial}{\partial x_k''}\left(\overline{u_l h_i' h_m''' h_k'' u_j''}\right)+\frac{\partial}{\partial x_k''}\left(\overline{u_l u_k'' h_i' h_j'' h_m'''}\right)$$
$$-\frac{\partial}{\partial x_k''{}'}\left(\overline{u_l u_k'' h_i' h_j'' h_m'''}\right)-\frac{\partial}{\partial x_k'''{}'}\left(\overline{u_l u_j'' h_i' h_j'' h_m'''}\right)=\frac{-\partial}{\partial x_l}\overline{(w h_i' h_j'' h_m''')}+\frac{\partial^2}{\partial x_k\partial x_k}\overline{(u_l h_i' h_j'' h_m''')}+$$

$$\frac{\nu}{p_M}\Big[\frac{\partial^2}{\partial x'_k \partial x'_k}(\overline{u_l h'_i h''_j h'''_m}) + \frac{\partial^2}{\partial x''_k \partial x''_k}(\overline{u_l h'_i h''_j h'''_m})\ \frac{\partial^2}{\partial x'''_k \partial x'''_k}(\overline{u_l h'_i h''_j h'''_m})\Big] -$$

$$\varepsilon_{pkl}\Omega_p\left(\overline{u_l h'_i h''_j h'''_m}\right) + \varepsilon_{qki}\Omega_q\left(\overline{u_l u'_i h''_j h'''_m}\right) + \varepsilon_{rkj}\Omega_r\left(\overline{u_l u''_j h'_i h'''_m}\right) +$$
$$\varepsilon_{skm}\Omega_s\left(\overline{u_l u'''_m h'_i h''_j}\right)\Big] + \mathrm{f}\left[\left(\overline{u_l h'_i h''_j h'''_m}\right) - \left(\overline{v_l h'_i h''_j h'''_m}\right)\right] \tag{9}$$

Using the transformations,

$$\frac{\partial}{\partial x''_k} = \frac{\partial}{\partial r'_k},\ \frac{\partial}{\partial x'_k} = \frac{\partial}{\partial r'_k},\ \frac{\partial}{\partial x_k} = -\left(\frac{\partial}{\partial r'_k} + \frac{\partial}{\partial r'_k} + \frac{\partial}{\partial r''_k}\right)$$

and the nine-dimensional Fourier transforms

$$\left\langle u_l h'_i(\hat r) h''_j(\hat r') h'''_m(\hat r'')\right\rangle = \int_{-\infty}^{\infty}\int_{-\infty}^{\infty}\int_{-\infty}^{\infty}\left\langle \phi_l \gamma'_i(\hat k)\gamma''_j(\hat k')\gamma'''_m(\hat k'')\right\rangle \exp[i(\hat k.\hat r + \hat k'.\hat r' + \hat k''.\hat r'')d\hat k d\hat k' d\hat k'', \tag{10}$$

$$\left\langle u_l u'_k h'_i(\hat r) h''_j(\hat r') h'''_m(\hat r'')\right\rangle = \int_{-\infty}^{\infty}\int_{-\infty}^{\infty}\int_{-\infty}^{\infty}\left\langle \phi_l \phi'_k(\hat k)\gamma'_i(\hat k)\gamma''_j(\hat k')\gamma''_m(\hat k'')\right\rangle \exp[i(\hat k.\hat r + \hat k'.\hat r' + \hat k''.\hat r'')d\hat k d\hat k' d\hat k'', \tag{11}$$

$$\left\langle u_l u'_i h'_i(\hat r) h''_j(\hat r') h'''_m(\hat r'')\right\rangle = \int_{-\infty}^{\infty}\int_{-\infty}^{\infty}\int_{-\infty}^{\infty}\left\langle \phi_l \phi'_i(\hat k)\gamma'_i(\hat k)\gamma''_j(\hat k')\gamma'''_m(\hat k'')\right\rangle \exp[i(\hat k.\hat r + \hat k'.\hat r' + \hat k''.\hat r'')d\hat k d\hat k' d\hat k'', \tag{12}$$

$$\left\langle u_l u''_k h'_i(\hat r) h''_j(\hat r') h'''_m(\hat r'')\right\rangle = \int_{-\infty}^{\infty}\int_{-\infty}^{\infty}\int_{-\infty}^{\infty}\left\langle \phi_l \phi''_k(\hat k')\gamma'_i(\hat k)\gamma''_j(\hat k')\gamma'''_m(\hat k'')\right\rangle \exp[i(\hat k.\hat r + \hat k'.\hat r' + \hat k''.\hat r'')d\hat k d\hat k' d\hat k'', \tag{13}$$

$$\left\langle u_l u''_j h'_i(\hat r) h''_k(\hat r') h'''_m(\hat r'')\right\rangle = \int_{-\infty}^{\infty}\int_{-\infty}^{\infty}\int_{-\infty}^{\infty}\left\langle \phi_l \phi''_j(\hat k')\gamma'_i(\hat k)\gamma''_j(\hat k')\gamma'''_m(\hat k'')\right\rangle \exp[i(\hat k.\hat r + \hat k'.\hat r' + \hat k''.\hat r'')d\hat k d\hat k' d\hat k'', \tag{14}$$

$$\left\langle u_l u_k h'_i(\hat r) h''_j(\hat r') h'''_m(\hat r'')\right\rangle = \int_{-\infty}^{\infty}\int_{-\infty}^{\infty}\int_{-\infty}^{\infty}\left\langle \phi_l \phi_k \gamma'_i(\hat k)\gamma''_j(\hat k')\gamma'''_m(\hat k'')\right\rangle \exp[i(\hat k.\hat r + \hat k'.\hat r' + \hat k''.\hat r'')d\hat k d\hat k' d\hat k'', \tag{15}$$

$$\left\langle u_l u'_i h'_i(\hat r) h''_j(\hat r') h'''_m(\hat r'')\right\rangle = \int_{-\infty}^{\infty}\int_{-\infty}^{\infty}\int_{-\infty}^{\infty}\left\langle \phi_l \phi'_i(\hat k')\gamma'_i(\hat k)\gamma''_j(\hat k')\gamma'''_m(\hat k'')\right\rangle \exp[i(\hat k.\hat r + \hat k'.\hat r' + \hat k''.\hat r'')d\hat k d\hat k' d\hat k'', \tag{16}$$

$$\left\langle w h'_i(\hat r) h''_j(\hat r') h'''_m(\hat r'')\right\rangle = \int_{-\infty}^{\infty}\int_{-\infty}^{\infty}\int_{-\infty}^{\infty}\left\langle \delta \gamma'_i(\hat k)\gamma''_j(\hat k')\gamma'''_m(\hat k'')\right\rangle \exp[i(\hat k.\hat r + \hat k'.\hat r' + \hat k''.\hat r'')d\hat k d\hat k' d\hat k'', \tag{17}$$

$$\left\langle v_l h'_i(\hat r) h''_j(\hat r') h'''_m(\hat r'')\right\rangle = \int_{-\infty}^{\infty}\int_{-\infty}^{\infty}\int_{-\infty}^{\infty}\left\langle \eta_l \gamma'_i(\hat k)\gamma''_j(\hat k')\gamma'''_m(\hat k'')\right\rangle \exp[i(\hat k.\hat r + \hat k'.\hat r' + \hat k''.\hat r'')d\hat k d\hat k' d\hat k'', \tag{18}$$

with the fact

$$\overline{u_l u'''_k h'_i h''_j h'''_m} = \overline{u_l u'_k h'_i h''_j h'''_m};\ \overline{u_l u'''_k h'_i h''_j h'''_m} = \overline{u_l u'_k h''_i h''_j h'''_m};$$
$$\overline{u_l u'''_m h'_i h''_j h'''_m} = \overline{u_l u'_i h'_i h'_k h''_j h'''_m};\ \overline{u_l u''_j h'_i h''_k h'''_m} = \overline{u_l u'_i h'_i h'_k h''_j h'''_m};$$

and by taking contraction of the indices *i* and *j*, *i* and *m*, we obtained four-point correlation equation as

$$\frac{\partial}{\partial t}\overline{(\phi_l\gamma_i'\gamma_i''\gamma_m''')}+\frac{\nu}{p_M}[(1+P_M)K^2+(1+p_M)K'^2+(1+p_M)K''^2+2p_MKK'+2p_MKK''+2p_MKK'']$$
$$\overline{(\phi_l\gamma_i'\gamma_i''\gamma_m''')}+\{2\varepsilon_{pkl}\Omega_p+2\varepsilon_{qki}\Omega_q+2\varepsilon_{rkj}\Omega_r+2\varepsilon_{skm}\Omega_s-f\}\left(\overline{\phi_l\gamma_i'\gamma_i''\gamma_m'''}\right)+f\left(\overline{\eta_l\gamma_i'\gamma_i''\gamma_m'''}\right)=$$
$$i(K_k+K_k'+K_k'')\ \overline{(\phi_l\phi_k\gamma_i'\gamma_i''\gamma_m''')}-i(K_k+K_k'+K_k'')\ \overline{(\gamma_l\gamma_k\gamma_i'\gamma_i''\gamma_m''')}-i(K_k+K_k'+K_k'')\ \overline{(\phi_l\phi_k'\gamma_i'\gamma_i''\gamma_m''')}$$
$$+i(K_k+K_k'+K_k'')\ \overline{(\phi_l\phi_i'\gamma_k\gamma_i''\gamma_m''')}+i(K_k+K_k'+K_k'')\ \overline{(\delta\gamma_i'\gamma_i''\gamma_m''')} \qquad (19)$$

If we take the derivative with respect to x_l of Eq. (5) and multiplying by $h_i'h_j''h_m'''$, using time averages and writing the equation in terms of the independent variables $\hat{r},\hat{r}',\hat{r}''$, we have

$$-\left(\overline{\delta\gamma_i'\gamma_j''\gamma_m'''}\right)=\frac{(K_lK_k+K_lK_k'+K_l'k_k'+K_l'K_k'+K_lK_K''+K_l'K_k''+K_kK_l''+K_k'K_l''+K_l''K_k'')}{(K_lK_l+K_l'K_l'+K_l''K_l''+2K_lK_l'+2K_{l'}K_{l''}''+2K_lK_l'')}\ \overline{(\phi_l\phi_k\gamma_i'\gamma_j''\gamma_m'''}-\overline{\gamma_l\gamma_k\gamma_i'\gamma_j''\gamma_m''')} \qquad (20)$$

Eqs. (19) and (20) are the spectral equation corresponding to the four-point correlation equation.

3.1. *Three-point correlation*

The spectral equations corresponding to the three-point correlation equations by contraction of the indices *i* and *j* are

$$\frac{\partial}{\partial t}\overline{(\phi_l\beta_i'\beta_i'')}+\frac{\nu}{p_M}[(1+P_M)(K^2+K'^2)+2p_MKK']\overline{(\phi_l\beta_i'\beta_i'')}=i(K_k+K_k')\ \overline{(\phi_l\phi_k\beta_i'\beta_i'')}-$$
$$i(K_k+K_k')\ \overline{(\beta_l\beta_k\beta_i'\beta_i'')}-i(K_k+K_k')\ \overline{(\phi_l\phi_k'\beta_i'\beta_i'')}+i(K_k+K_k')\ \overline{(\phi_l\phi_i'\beta_i'\beta_i'')}+i(k_l+k_l')\overline{\gamma\beta_i'\beta_i''} \qquad (21)$$
$$-\overline{(\gamma\beta_i'\beta_j'')}=\frac{(K_lK_k+K_l'K_k+K_lk_k'+K_l'K_k')}{(K_l^2+K_l'^2+2K_lK_l')}\ \overline{(\phi_l\phi_k\beta_i'\beta_i''}-\overline{\beta_l\beta_k\beta_i'\beta_j'')} \qquad (22)$$

Here the spectral tensors are defined by

$$\left\langle u_lh_i'(\hat{r})h_j''(\hat{r}')\right\rangle=\int_{-\infty}^{\infty}\int_{-\infty}^{\infty}\left\langle\phi_l\beta_i'(\hat{k})\beta_j''(\hat{k}')\right\rangle\exp[i(\hat{k}.\hat{r}+\hat{k}'.\hat{r}')d\hat{k}d\hat{k}', \qquad (23)$$

$$\left\langle u_lu_k'(\hat{r})h_i'(\hat{r})h_j''(\hat{r}')\right\rangle=\int_{-\infty}^{\infty}\int_{-\infty}^{\infty}\left\langle\phi_l\phi_k'(\hat{k})\beta_i'(\hat{k})\beta_j''(\hat{k}')\right\rangle\exp[i(\hat{k}.\hat{r}+\hat{k}'.\hat{r}')d\hat{k}d\hat{k}', \qquad (24)$$

$$\left\langle u_lu_i'(\hat{r})h_i'(\hat{r})h_j''(\hat{r}')\right\rangle=\int_{-\infty}^{\infty}\int_{-\infty}^{\infty}\left\langle\phi_l\phi_i'(\hat{k})\beta_i'(\hat{k})\beta_j''(\hat{k}')\right\rangle\exp[i(\hat{k}.\hat{r}+\hat{k}'.\hat{r}')d\hat{k}d\hat{k}', \qquad (25)$$

$$\left\langle u_lh_i'(\hat{r})h_j''(\hat{r}')\right\rangle=\int_{-\infty}^{\infty}\int_{-\infty}^{\infty}\left\langle\phi_l\beta_i'(\hat{k})\beta_j''(\hat{k}')\right\rangle\exp[i(\hat{k}.\hat{r}+\hat{k}'.\hat{r}')d\hat{k}d\hat{k}', \qquad (26)$$

$$\left\langle u_lh_k(\hat{r})h_i'(\hat{r})h_j''(\hat{r}')\right\rangle=\int_{-\infty}^{\infty}\int_{-\infty}^{\infty}\left\langle\phi_l\beta_k(\hat{k})\beta_i'(\hat{k})\beta_j''(\hat{k}')\right\rangle\exp[i(\hat{k}.\hat{r}+\hat{k}'.\hat{r}')d\hat{k}d\hat{k}', \qquad (27)$$

$$\left\langle wh_i'(\hat{r})h_j''(\hat{r}')\right\rangle = \int_{-\infty}^{\infty}\int_{-\infty}^{\infty}\left\langle \gamma\beta_i'(\hat{k})\beta_j''(\hat{k}')\right\rangle \exp[i(\hat{k}.\hat{r}+\hat{k}'.\hat{r}')d\hat{k}d\hat{k}'. \tag{28}$$

A relation between $\phi_l\phi_k'\beta_i'\beta_j''$ *and* $\phi_l\gamma_i'\gamma_j''\gamma_m'''$ can be obtained by letting $\hat{r}''=0$ in Eq. (10) and comparing the result with Eq. (24), we get

$$\left\langle \phi_l\phi_k'(\hat{k})\beta_i'(\hat{k})\beta_j''(\hat{k}')\right\rangle = \int_{-\infty}^{\infty}\left\langle \phi_l\gamma_i'(\hat{k})\gamma_j''(\hat{k}')\gamma_m'''(\hat{k}'')\right\rangle d\hat{k}'' \tag{29}$$

3.2. *Two-point correlation*

The spectral equation corresponding to the two point correlation equation taking contraction of the indices is

$$\frac{\partial}{\partial t}\left\langle \varphi_i\varphi_i'(\hat{k})\right\rangle + \frac{2\nu}{p_M}k^2\left\langle \varphi_i\varphi_i'(\hat{k})\right\rangle = 2ik_k[\left\langle \alpha_i\varphi_k\varphi_i'(\hat{k})\right\rangle - \left\langle \alpha_k\varphi_i\varphi_i'(-\hat{k})\right\rangle] \tag{30}$$

where,

$\varphi_i\varphi_i'$ and $\alpha_i\phi_k\phi_i'$ are defined by

$$\left\langle h_ih_i'(\hat{r})\right\rangle = \int_{-\infty}^{\infty}\left\langle \varphi_i\varphi_i'(\hat{k})\right\rangle \exp[i(\hat{k}.\hat{r})]d\hat{k} \tag{31}$$

$$\left\langle u_ih_ih_i'(\hat{r})\right\rangle = \int_{-\infty}^{\infty}\left\langle \alpha_i\varphi_k\varphi_i'(\hat{k})\right\rangle \exp[i(\hat{k}.\hat{r})]d\hat{k} \tag{32}$$

The relation between $\alpha_i\varphi_k\varphi_j'(\hat{k})$ and $\varphi_l\beta_i'\beta_j''$ is obtained by letting $\hat{r}'=0$ in Eq. (22) and comparing the result with Eq. (31), then

$$\left\langle \alpha_i\varphi_k\varphi_i'(\hat{k})\right\rangle = \int_{-\infty}^{\infty}\left\langle \phi_l\beta_i'(\hat{k})\beta_i''(\hat{k}')\right\rangle d\hat{k}' \tag{33}$$

4. Solution Neglecting Quintuple Correlations

Using $f\left(\overline{\eta_l\gamma_i'\gamma_i''\gamma_m'''}\right)=R\left(\overline{\phi_l\gamma_i'\gamma_i''\gamma_m'''}\right)$, 1-*R*=s, and neglecting all the terms on the right side of Eq. (19), then integrating between t_1 and t, we get

$$\left\langle \phi_l\gamma_i'\gamma_j''\gamma_m'''\right\rangle = \left\langle \phi_l\gamma_i'\gamma_j''\gamma_m'''\right\rangle_1 .\ \exp\{\frac{-\nu}{p_M}(1+p_M)\left(k^2+k'^2+k''^2+2kk'+2k'k''+2kk'\right) - 2\left(\varepsilon_{pkl}\Omega_p+\varepsilon_{qki}\Omega_q+\varepsilon_{rkj}\Omega_r+\varepsilon_{skm}\Omega_s\right)+fs\}(t-t_1) \tag{34}$$

where $\left\langle \phi_l\gamma_i'\gamma_j''\gamma_m'''\right\rangle_1$ is the value of $\left\langle \phi_l\gamma_i'\gamma_j''\gamma_m'''\right\rangle$ at *t*= t_1 that is stationary value for small values of k, k' and k''.Substituting of Eqs. (22), (29), (34) in Eq. (21) and integrating with respect to k_1'', k_2'', k_3'' and farther integrating with respect to time, and in order to simplify calculations, we will assume that $[a]_1=0$;That is we assume that a function sufficiently general to represent the initial conditions can obtained by considering only the terms involving $[b]_1$ and $[c]_1$ and the integration is performed, then substituting the obtained equation in Eq. (30) and setting $H = 2\pi k^2 \varphi_i \varphi_i'$,we obtain

$$\frac{\partial H}{\partial t} + (\frac{2\nu k^2}{p_M})H = G \tag{35}$$

where ,

$$G = k^2 \int_{-\infty}^{\infty} 2\pi . i[\langle k_k \phi_l \beta_i' \beta_i''(\hat{k}, \hat{k}') \rangle - \langle k_k \phi_l \beta_i' \beta_i''(-\hat{k}, -\hat{k}') \rangle]_0$$
$$\cdot \exp\{-(2\varepsilon_{pkl}\Omega_p + 2\varepsilon_{qki}\Omega_q + 2\varepsilon_{rkj}\Omega_r - fs)(t - t_o)\}$$
$$\exp[-\frac{\nu}{p_M}(t - t_0)\{(1 + p_M)(k^2 + k'^2) + 2p_M kk'\}]dk'$$
$$+ k^2 \int_{-\infty}^{\infty} \frac{2p_M . \pi^{\frac{5}{2}}}{\nu} i[b(\hat{k}.\hat{k}') - b(-\hat{k}. - \hat{k}')]_1 \cdot \exp\{-(2\varepsilon_{pkl}\Omega_p + 2\varepsilon_{qki}\Omega_q + 2\varepsilon_{rkj}\Omega_r + 2\varepsilon_{skm}\Omega_s - fs)(t - t_1)\}$$
$$.\{-\omega^{-1} \exp[-\omega^2\left(\frac{(1 + 2p_M)k^2}{(1 + p_M)^2} + \frac{2P_m kk'}{1 + p_M} + k'^2\right)]$$
$$+ k.\exp\ [-\omega^2(\ (1 + p_M)(k^2 + k'^2) + 2p_M kk'\ ] \int_0^{\frac{\omega k}{2}} \exp(x^2)dx\}dk'$$
$$+ k^2 \int_{-\infty}^{\infty} \frac{2p_M . \pi^{\frac{5}{2}}}{\nu} i[c(\hat{k}.\hat{k}') - c(-\hat{k}. - \hat{k}')]_1$$
$$\exp\{-(2\varepsilon_{pkl}\Omega_p + 2\varepsilon_{qki}\Omega_q + 2\varepsilon_{rkj}\Omega_r + 2\varepsilon_{skm}\Omega_s - fs)(t - t_1)\}$$
$$\{-\omega^{-1} \exp[-\omega^2\left(k^2 + \frac{2P_m kk'}{1 + p_M} + \frac{(1 + 2p_M)k'^2}{(1 + p_M)^2}\right)]$$
$$+ k' \exp[-\omega^2(\ (1 + p_M)(k^2 + k'^2) + 2p_M kk')]. \int_0^{\frac{\omega k'}{2}} \exp(x^2)dx\}dk' \tag{36}$$

where H is the magnetic energy spectrum function, which represents contributions from various wave numbers to the energy and G is the energy transfer function, which is responsible for the transfer of energy between wave numbers .In order to make further calculations, an assumption must be made for the forms of the bracketed quantities with the subscripts 0 and 1 in Eq. (36) which depends on the initial conditions.

$$(2\pi)^2 [\langle k_k \phi_l \beta_i' \beta_i''(\hat{k}, \hat{k}') \rangle - \langle k_k \phi_l \beta_i' \beta_i''(-\hat{k}, -\hat{k}') \rangle]_0 = -\xi_0 (k^2 k'^4 - k^4 k'^2) \tag{37}$$

where ξ_0 is a constant depending on the initial conditions for the other bracketed quantities in Eq. (36), we get

$$\frac{4p_M.\pi^{\frac{7}{2}}}{\nu} i\left[b(\hat{k}.\hat{k}') - b(-\hat{k}.-\hat{k}')\right]_1 = \frac{4p_M.\pi^{\frac{7}{2}}}{\nu} i\left[c(\hat{k}.\hat{k}') - c(-\hat{k}.-\hat{k}')\right]_1 = -2\xi_1(k^4k'^6 - k^6k'^4) \qquad (38)$$

Remembering, $d\hat{k}' = 2\pi\hat{k}'^2 d(\cos\theta)dk'$ and $kk' = kk'\cos\theta$, θ is the angle between $\hat{k}$ and $\hat{k}'$ and carrying out the integration with respect to θ, we get

$$\begin{aligned}
G = -\int_0^\infty [&\frac{\xi_0(k^2k'^4 - k^4k'^2)kk'}{\nu(t-t_0)}\{\exp[-\frac{\nu}{p_M}(t-t_0)\{(1+p_M)(k^2+k'^2) - 2p_M kk'\}] - \\
&\exp[-\frac{\nu}{p_M}(t-t_0)\{(1+p_M)(k^2+k'^2) + 2p_M kk'\}]\} \\
&+ \frac{\xi_1(k^4k'^6 - k^6k'^4)kk'}{\nu(t-t_0)} \exp\{(-2\varepsilon_{pkl}\Omega_p - 2\varepsilon_{qki}\Omega_q - 2\varepsilon_{rkj}\Omega_r - 2\varepsilon_{skm}\Omega_s + fs)(t-t_1)\}. \\
&(\omega^{-1}\exp[-\omega^2\left(\frac{(1+2p_M)k^2}{(1+p_M)^2} - \frac{2P_M kk'}{1+p_M} + k'^2\right)] \\
&-\omega^{-1}\exp[-\omega^2\left(\frac{(1+2p_M)k^2}{(1+p_M)^2} + \frac{2P_M kk'}{1+p_M} + k'^2\right)] + \\
&\omega^{-1}\exp[-\omega^2\left(k^2 - \frac{2P_M kk'}{1+p_M} + \frac{(1+2p_M)k'^2}{(1+p_M)^2}\right)] \\
&-\omega^{-1}\exp[-\omega^2\left(k^2 + \frac{2P_M kk'}{1+p_M} + \frac{(1+2p_M)k'^2}{(1+p_M)^2}\right)] \\
&+ \{k\exp[-\omega^2((1+p_M)(k^2+k'^2) - 2p_M kk')] \\
&-k\exp[-\omega^2((1+p_M)(k^2+k'^2) + 2p_M kk')]\}\int_0^{\frac{\omega k}{2}}\exp(x^2)dx \\
&+ \{k'\exp[-\omega^2((1+p_M)(k^2+k'^2) - 2p_M kk')] \\
&-k'\exp[-\omega^2((1+p_M)(k^2+k'^2) + 2p_M kk')]\}\int_0^{\frac{\omega k'}{2}}\exp(x^2)dx)]dk'
\end{aligned} \qquad (39)$$

Here, $\omega = \left(\frac{\nu(t-t_1)(1+p_M)}{p_M}\right)^{\frac{1}{2}}$. Integrating Eq. (39) with respect to k', we have

$$G = G_\beta + G_\gamma \exp\{-(2\varepsilon_{pkl}\Omega_p + 2\varepsilon_{qki}\Omega_q + 2\varepsilon_{rkj}\Omega_r + 2\varepsilon_{skm}\Omega_s - fs)(t-t_1)\} \qquad (40)$$

where,

$$G_\beta = -\frac{\pi^{\frac{1}{2}}\xi_0 p_M^{\frac{5}{2}}}{\nu^{\frac{3}{2}}(t-t_0)^{\frac{3}{2}}(1+p_M)^{\frac{5}{2}}}\exp\left\{-\frac{\nu(t-t_0)(1+2p_M)k^2}{p_M(1+p_M)}\right\}$$
$$.\left[\frac{15p_M k^4}{4\nu^2(t-t_0)^2(1+p_M)} + \left\{\frac{5p_M^2}{(1+p_M)^2\nu(t-t_0)} - \frac{3}{2\nu(t-t_0)}\right\}k^6 + \frac{p_M}{1+p_M}\left\{\frac{p_M^2}{(1+p_M)^2} - 1\right\}k^8\right]$$

and $G_\gamma = G_{\gamma_1} + G_{\gamma_2} + G_{\gamma_3} + G_{\gamma_4}$

Here,

$$G_{\gamma_1} = \frac{\xi_1 \pi^{\frac{1}{2}} p_M{}^5}{8\nu^2 (t-t_1)^2 (1+p_M)^5} \exp\left(\frac{-\nu(t-t_1)(1+2p_M-p_M{}^2)}{p_M(1+p_M)}\right) k^2 \cdot$$

$$[\frac{90 p_M k^6}{\nu^4 (t-t_1)^4 (1+p_M)} + 3\{\frac{4p_M}{\nu^2(t-t_1)^2(1+p_M)} + \frac{2p^2{}_M}{\nu^3(t-t_1)^3(1+p_M)^2} - \frac{1}{\nu^3(t-t_1)^3}\}k^8$$

$$+\{\frac{64p^2{}_M}{\nu(t-t_1)(1+p_M)^2} + \frac{10p^3{}_M}{\nu^2(t-t_1)^2(1+p_M)^3} - \frac{40}{\nu(t-t_1)}\}k^{10} + 8\{(\frac{p_M}{1+p_M})^2 - (\frac{p_M}{1+p_M})\}k^{12}]$$

$$G_{\gamma_2} = \frac{\xi_1 \pi^{\frac{1}{2}} p_M{}^5 (1+p_M)^4}{8\nu^2(t-t_1)^2(1+2p_M)^{\frac{9}{2}}} \exp(\frac{-\nu(t-t_1)(1+p_M)(1+2p_M-2p^2{}_M)}{p_M(1+p_M)})k^2$$

$$[\frac{90p_M(1+p_M)k^6}{\nu^4(t-t_1)^4(1+2p_M)} + \{\frac{120p_M(1+p_M)}{\nu^2(t-t_1)^2(1+p_M)} + \frac{2p^2{}_M(1+p_M)^2}{\nu^3(t-t_1)^3(1+2p_M)^2} - \frac{1}{\nu^3(t-t_1)^3}\}k^8$$

$$+\{\frac{64p^2{}_M(1+p_M)^2}{\nu(t-t_1)(1+2p_M)^2} - \frac{40}{\nu(t-t_1)} + \frac{10p^3{}_M(1+p_M)^3}{\nu^2(t-t_1)^2(1+2p_M)^3}\}k^{10} + \{\frac{8p^3{}_M(1+p_M)^3}{(1+2p_M)^3} - \frac{p_M(1+p_M)}{(1+2p_M)}\}k^{12}]$$

$$G_{\gamma_3} = \frac{\xi_1 \pi^{\frac{1}{2}} p^{\frac{9}{2}}{}_M}{8\nu^{\frac{3}{2}}(t-t_1)^{\frac{3}{2}}(1+p_M)^8} \exp(\frac{-\nu(t-t_1)(1+p_M)(1+2p_M-2p^2{}_M)}{p_M(1+p_M)})k$$

$$[\frac{90p_M k^7}{\nu^2(t-t_1)^2(1+p_M)^2} + \{\frac{120p_M}{\nu^2(t-t_1)^2} + \frac{60p^2{}_M}{\nu^3(t-t_1)^3(1+p_M)^2} - \frac{30}{\nu^3(t-t_1)^3}\}k^9$$

$$+\{\frac{64p^2{}_M}{\nu(t-t_1)} + \frac{10p^3{}_M}{\nu^2(t-t_1)^2(1+p_M)^2} - \frac{40(1+p_M)^2}{\nu(t-t_1)}\}k^{11} + \{p^2{}_M - p_M(1+p_M)^2\}k^{13}]\int_0^{\frac{\omega_1}{2}} \exp(y^2)dy$$

Here, $\omega_1 = \left(\frac{\nu(t-t_1)(1+p_M)}{p_M}\right)^{\frac{1}{2}} k$

$$G_{\gamma_4} = \frac{\xi_1 \pi^{1/2} p^{15/2}{}_M}{2^8 \nu(t-t_1)(1+p_M)^{29/2}} \exp(\frac{-\nu(t-t_1)(1+p_M)(1+2p_M)}{p_M})k^2$$

$$[\frac{7560(1+p_M)^3}{\nu^4(t-t_1)^2 p^2{}_M}k^6 + \{\frac{20160(1+p_M)^5}{\nu^3(t-t_1)^3 p_M} - \frac{4233600(1+p_M)^7}{\nu^3(t-t_1)^3 p^3{}_M}\}k^8 +$$

$$\{\frac{12096(1+p_M)^5}{\nu^2(t-t_1)^2} - \frac{3360(1+p_M)^7}{\nu^2(t-t_1)^2 p^2{}_M}\}k^{10} + \{\frac{2304(1+p_M)^5 p_M}{\nu(t-t_1)} - \frac{1344(1+p_M)^9}{p^2{}_M}\}k^{12}$$

$$\{128(1+p_M)^5 p^2{}_M - 128(1+p_M)^7\}k^{14} + \ldots]$$

The integral expression in Eq. (40), the quantity G_β represents the transfer function arising owing to consideration of magnetic field at three point correlation equation; G_γ arises from consideration of the four-point equation. Integration of Eq. (40) over all wave numbers shows that

$$\int_0^\infty G \, d\mathbf{k} = 0 \tag{41}$$

Indicating that the expression for G satisfies the conditions of continuity and homogeneity, physically, it was to be expected, since G is a measure of transfer of energy and the numbers must be zero. From (35),

$$H=\exp\left[-\frac{2\nu k^2(t-t_0)}{p_M}\right]\int G\exp\left[-\frac{2\nu k^2(t-t_0)}{p_M}\right]dt+J(k)\exp\left[-\frac{2\nu k^2(t-t_0)}{p_M}\right],$$

where, $J(k)=\frac{N_0k^2}{\pi}$ is a constant of integration and can be obtained as by Corrsin [18].

Therefore we obtain,

$$H=\frac{N_0k^2}{\pi}\exp[\frac{-2\nu k^2(t-t_0)}{p_M}]+\exp[\frac{-2\nu k^2(t-t_0)}{p_M}]\int[G_\beta+(G_{\gamma_1}+G_{\gamma_2}+G_{\gamma_3}+G_{\gamma_4})$$
$$\exp\{-(2\varepsilon_{pkl}\Omega_p+2\varepsilon_{qki}\Omega_q+2\varepsilon_{rkj}\Omega_r+2\varepsilon_{skm}\Omega_s-fs)(t-t_1)\}]\exp[\frac{-2\nu k^2(t-t_0)}{p_M}]\underline{dt} \qquad (42)$$

From Eq. (42), we get

$$H=H_1+H_2\exp\{(-2\varepsilon_{pkl}\Omega_p-2\varepsilon_{qki}\Omega_q-2\varepsilon_{rkj}\Omega_r-2\varepsilon_{skm}\Omega_s+fs)(t-t_1)\} \qquad (43)$$

In Eq. (43) H_1 and H_2 magnetic energy spectrum arising from consideration of the three and four–point correlation equations respectively. Eq. (43) can be integrated over all wave numbers to give the total magnetic turbulent energy.

$$\frac{\langle h_ih_i'\rangle}{2}=\frac{N_0p^{\frac{3}{2}}{}_M\nu^{\frac{-3}{2}}(t-t_0)^{\frac{-3}{2}}}{8\sqrt{2\pi}}+\xi_0.Q.\nu^{-6}.(t-t_0)^{-5}+[\xi_1R\nu^{-\frac{17}{2}}(t-t_1)^{-\frac{15}{2}}+\xi_1S\nu^{-\frac{19}{2}}(t-t_1)^{-\frac{17}{2}}]$$
$$\exp\{-(2\varepsilon_{pkl}\Omega_p+2\varepsilon_{qki}\Omega_q+2\varepsilon_{rkj}\Omega_r+2\varepsilon_{skm}\Omega_s-fs)(t-t_1)\} \qquad (44)$$

which represents the equation of the decay of dusty MHD turbulence in a rotating system. Here, $R=Q_2+Q_4+Q_6+Q_7, S=Q_1+Q_3+Q_5$ and $Q^{,s}$ values

$$Q=\frac{\pi.p^6M}{(1+P_M)(1+2P_M)^{5/2}}$$
$$\left\{\frac{9}{16}+\frac{5P_M(7P_M-6)}{(1+2P_M)}-\frac{35P_M(3p^2{}_M-2p_M+3)}{8(1+2p_M)^2}+\frac{8p_M(3p^2{}_M-2p_M+3)}{3.2^6.(1+2p_M)^3}+\ldots\right\}$$

$$Q_1=-\frac{\pi.p^6M}{(1+P_M)^{5/2}(1+2P_M-p^2{}_M)^{7/2}}$$
$$\left\{\begin{array}{l}\frac{15.9}{2^6}+\frac{15.7(15-6p_M+21p^2{}_M)}{2^{10}(1+2P_M-p^2{}_M)}+\frac{15.7.3(15-6p_M+36p^2{}_M-6p^3{}_M+61p^4{}_M)}{2^{11}(1+2p_M-p^2M)^2}+\\ \frac{11.9.7(1+P^2{}_M)(75-30p_M+180p^2{}_M-30p^3{}_M+305p^4{}_M)}{2^{13}(1+2p_M-p^2M)^3}+\\ \frac{13.11.9.7(1+P^2{}_M)^2(75-3p_M+90p^2{}_M-30p^3{}_M+15p^4{}_M)}{2^{14}(1+2p_M-p^2M)^4}-\ldots\end{array}\right\}$$

$$Q_2 = -\frac{\pi.p^{21/2}{}_M}{(1+p_M)^{3/2}(1+2p_M-p^2{}_M)^{9/2}}$$

$$[\frac{15.7}{2^6}+\frac{15.9.7(14p^2{}_M-18-40p_M)}{2^9(1+2p_M-p^2{}_M)}+$$

$$\frac{15.11.9.7(14p^4{}_M-56p^3{}_M-12p^2{}_M-40p_M-18)}{2^{10}(1+2p_M-p^2{}_M)^2}-\quad\ldots]$$

$$Q_3 = -\frac{\pi.p^{19/2}{}_M(1+p_M)^{1/2}}{(1+2p_M)^2(1+2p_M-p^2{}_M)^{7/2}}\quad .$$

$$[\frac{9.15}{2^6}+\frac{15.7(17+32p_M-2p^2{}_M+4p^3{}_M+20p^4{}_M)}{2^{10}(1+p_M)^2(1+2p_M-p^2{}_M)}$$

$$+\frac{9.7.5(17+49p_M+13p^2{}_M-13p^3{}_M+98p^4{}_M+134p^5{}_M+104p^6{}_M+60p^7{}_M)}{2^{11}(1+p_M)^3(1+2p_M-p^2{}_M)^2}$$

$$+(\frac{(11.9.7.5(1+p_M-p^2{}_M+p^3{}_M)(17+49p_M+13p^2{}_M-13p^3{}_M+98p^4{}_M+134p^5{}_M+104p^6{}_M+60p^7{}_M)}{2^{13}(1+p_M)^4(1+2p_M-p^2{}_M)^3}$$

$$+(\frac{(13.11.9.7.5(1+p_M-p^2{}_M+p^3{}_M)^2(17+49p_M+13p^2{}_M-13p^3{}_M+98p^4{}_M+134p^5{}_M+104p^6{}_M+60p^7{}_M)}{2^{14}(1+p_M)^5(1+2p_M-p^2{}_M)^4})-\ldots]$$

$$Q_4 = -\frac{\pi.p^{21/2}M}{(1+P_M)^{1/2}(1+2P_M)(1+2P_M-p^2M)^{9/2}}\frac{[25.7.3}{2^5}+$$

$$\frac{15.9.7(-40p_M-48P^2{}_M+64p^3m+52p^4{}_M)+}{2^9(1+p_M)^2(1+2p_m-p^2m)}$$

$$\frac{15.11.9.7(-40p_M-89p^2{}_M+51p^3{}_M+124p^4M-40p^5{}_M+36p^6{}_M+60p^7{}_M)}{2^{10}(1+p_M)^3(1+2p_M-p^2{}_M)^2}\ldots]$$

$$Q_5 = -\frac{\pi.p^{19/2}M}{(1+P_M)^{19/2}(1+2P_M)^{9/2}}$$

$$\left\{\begin{array}{l}\frac{45.7.53}{2^{10}}+\frac{9.7.5.3(20p^2{}_M-70p_M-5)}{2^{11}(1+2P_M)}+\frac{11.9.7.5.3(20p^4{}_M-40p^3{}_M+160p^2{}_M-60p_M-5)}{2^{13}(1+2p_M-p^2M)^2}+\\ \frac{13.11.9.7.5.3(1-2p_M)(20p^4{}_M-40p^3{}_M+160p^2{}_M-60p_M-5)}{2^{14}(1+2p_M)^3}-\ldots\end{array}\right\}$$

$$Q_6 = -\frac{\pi.p^{21/2}M}{(1+P_M)^{15/2}(1+2P_M)^{11/2}}$$

$$\left\{\frac{15.9.7.5.3}{2^8}+\frac{11.9.7.5.3(24p^2{}_M-200p_M+20)}{2^{11}(1+2P_M)}-\ldots\right\}$$

$$Q_7 = -\frac{\pi.p^9{}_M}{(1+p_M)^{23/2}(1+2p_M)^{7/2}}$$

$$[\{\frac{9.7.5.3}{2^{11}}-\frac{7.5.3(4231710+16938180p_M+25381440p^2{}_M+1689480p^3{}_M+4213440p^4{}_M}{2^{13}(1+2p_M)}\}$$

$$(9.7.5.3(2115855+4237380p_M-4245780p^2{}_M-16927680p^3{}_M-14783328p^4{}_M$$

$$-\{\frac{-4218816p^5{}_M-4368p^6{}_M)}{2^{14}(1+2p_M)^2}\}...]$$

Eq. (44) can be written as

$$\frac{\langle h^2\rangle}{2}=A(t-t_0)^{\frac{-3}{2}}+B(t-t_0)^{-5}+\left[C(t-t_1)^{\frac{-15}{2}}+D(t-t_1)^{\frac{-17}{2}}\right]\exp[(-f+M)(t-t_1)]. \tag{45}$$

where $f=2\Omega\sin\varphi$ is the Coriolis parameter, M is the dust particle parameter, $\langle h^2\rangle$ denotes the total energy that is, mean square of the magnetic field fluctuation in four-point correlation, t is the time, and A , B, C, D, t_0 and t_1 are arbitrary constants determined by the initial conditions . The first term of right hand side of Eq. (45) corresponds to the energy of magnetic field fluctuation of two-point correlation; the second term represents magnetic energy for the three-point correlation; the third and fourth term represents magnetic energy for four-point correlation. If Coriolis force and dust particles are absent then Eq. (45) is of the form

$$\frac{\langle h^2\rangle}{2}=A(t-t_0)^{\frac{-3}{2}}+B(t-t_0)^{-5}+C(t-t_1)^{\frac{-15}{2}}+D(t-t_1)^{\frac{-17}{2}}. \tag{46}$$

which is the energy decay of MHD turbulence for four-point correlation in non rotating system. If $\xi_1=0$ then the Eq. (46) becomes

$$\frac{\langle h^2\rangle}{2}=A(t-t_0)^{\frac{-3}{2}}+B(t-t_0)^{-5}. \tag{47}$$

This was obtained earlier by Sarker and Kishore [6]. For large times, the second term in the equation becomes negligible, leaving the -3/2 power decay law for the final period.

5. Results and Discussion

This study shows that the terms associated with the higher-order correlation’s die out faster than those associated with the lower order ones**.** Here three and four-point correlations between fluctuating quantities have been considered and the quintuple correlations are neglected in comparison to the third and fourth order correlations. If the quadruple and quintuple correlations were not neglected, Eq. (44) contains more terms in negative higher power of $(t-t_1)$ and $(t-t_0)$ would be added to Eq. (44). In this case, the energy decay of MHD turbulence is greater than the four-point correlation in a rotating or non-rotating system. Here Eqs. (45) and (46) are represented by $y1$,$y2$,$y3$,$y4$,$y5$ and $y6$,$y7$,$y8$,$y9$,$y10$ respectively corresponding to the values $t_0=t_1=.5$, 1, 1.5, 2, 2.5. For different values of f and M, the energy decay curves obtained from Eqs. (46) and (44) are plotted in Figs. 1 to 6, respectively.

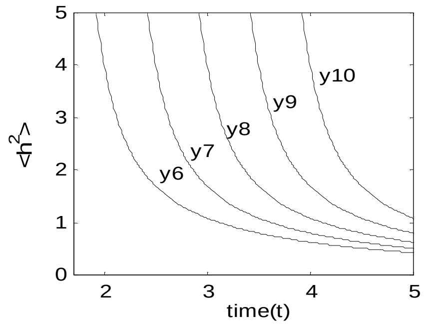

Fig. 1. Energy decay curves for f = 0,M = 0.

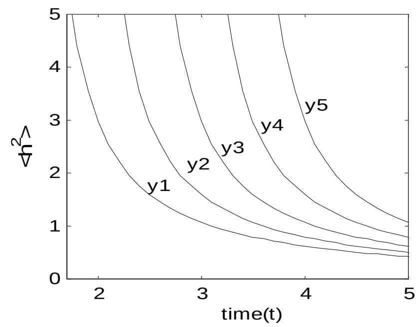

Fig. 2. Energy decay curves for f = 2.54, M = 0.

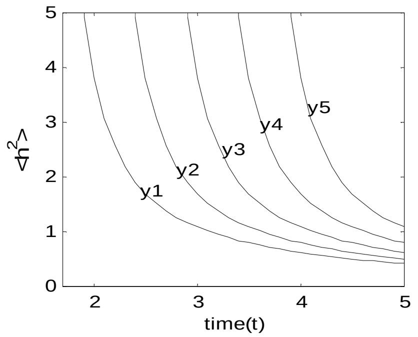

Fig. 3. Energy decay curves for f = 2.54, M = 2.

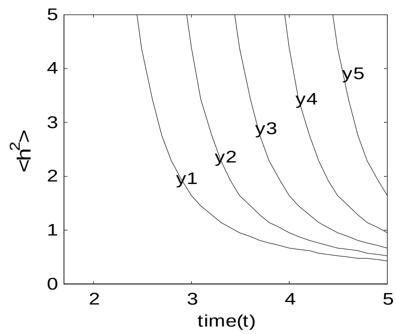

Fig. 4. Energy decay curves for f = 0, M = 2.54.

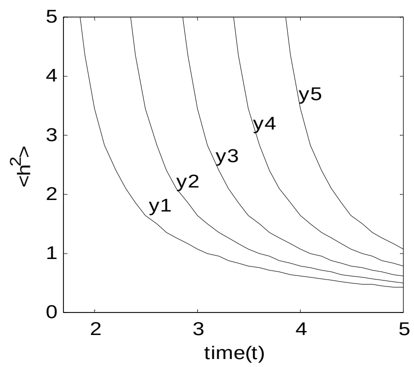

Fig. 5. Energy decay curves for f = 2.54, M = 1.54.

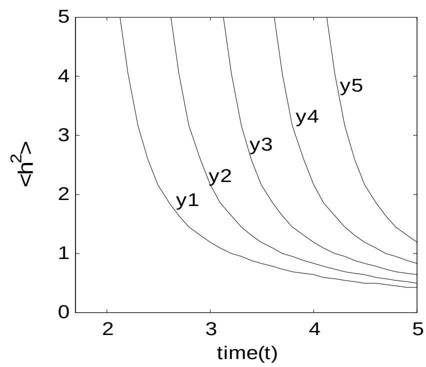

Fig. 6. Energy decay curves for f = 1.54, M = 2.54.

6. Conclusion

If f and M are equal then the solution of (45) reduces to Eq. (46) that is the decay of four-point correlation of MHD turbulence. We see that in a rotating system the energy decays slower than the non rotating system for four-point correlation in MHD turbulence due to $f>M$. From Figs. 1 to 6, we observe that in a rotating system if $f<M$ the energy die out very faster than the non rotating system. Therefore, the decay of energy of dusty fluid MHD turbulence in a rotating system for four-point correlation is greater than the decay of MHD turbulence for non rotating system if f-M is negative sign and smaller if f-M is positive sign in the Eq. (45).

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