Nuclear Activity in Galaxies Across Cosmic Time
Proceedings IAU Symposium No. 356, 2019
M. Pović, P. Marziani, J. Masegosa, H. Netzer, S. H. Negu & S. B. Tessema, eds.
doi:10.1017/S1743921320003166

The role of active galactic nuclei in galaxy evolution in terms of radial pressure

Biressa Tolu[1] **and Abate Feyissa**[2]

[1]Department of Physics, Astronomy and Space Stream, Jimma University, Jimma, Ethiopia
email: tolu_biressa@yahoo.com

[2]Department of Physics, Mada Walabu University, Robe, Ethiopia

Abstract. Irrespective of whether Active Galactic Nuclei (AGN) is cored with Supermassive Black Holes (SMBH) or not, there is a general consensus that observations indicate that the AGN plays fundamental role in galaxy evolution. The accretion disc powered fueling of the AGN and counter-feedback on its environment in the form of stress-energy-momentum along the radial component and an associated polodial jets seems viable model. On the theoretical ground there is no unified theory that compromise the observations. But there are pull of such diverse physics simulated to describe the observational works. So, there is unsettled theoretical framework how the activity of the AGN plays role in the evolution of host galaxy. Motivated by this we studied the role of AGN on its host galaxy evolution where General relativistic (GR) Magnetohydrodynamics (MHD) equation is considered to derive radial pressure that invokes star forming cold gases. Methodologically the central engine of the AGN is considered with SMBH/pseudo-SMBH. Locally, around the AGN, Reissner-Nordstrom-de Sitter metric is considered that reduces to the Schwarzschoild-de Sitter (SdS) background. Geometrically, a simple spherical geometry is superimposed with central disc structure assumed by cored void mass ablating model. The results of the work indicates that the AGN plays role in galaxy evolution, especially in the nearby environment. Also we report that the adjacent envelope to the AGN seems quiet with no activity in formation.

Keywords. AGN, GR, MHD, Reissner-Nordstrom-de Sitter metric, SMBH, Galaxy evolution

1. Introduction

Regardless of whether Active Galactic Nuclei (AGN) is cored with Supermassive Blackholes (SMBH) or not, there is a general consensus that observations indicate that the AGN plays role in hosting galaxy evolution. The accretion disc powered fueling of the AGN and counter-feedback on its environment in the form of stress-energy-momentum along the radial component and an associated polodial jets seems a viable model (Yuan *et al.* 2018, Camera *et al.* 2018, McKinnon *et al.* 2018). On the theoretical ground there is no unified theory that compromise the observations; but there are pull of such diverse physics simulated to describe the observational works. Thus, we develop an extended General relativistic Tolman-Oppenheimer-Volkoff (TOV) equations of AGN with such geometry and additional void cores to study the role of AGN on its host galaxy evolution where the equation is considered to derive radial pressure that invokes star forming cold gases.

2. Method

Methodologically the central engine of the AGN is considered with SMBH/pseudo-SMBH. Locally, spacetime around the AGN is considered with Reissner-Nordstrom-de Sitter metric that reduces to the Schwarzschoild-de Sitter (SdS) background retaining

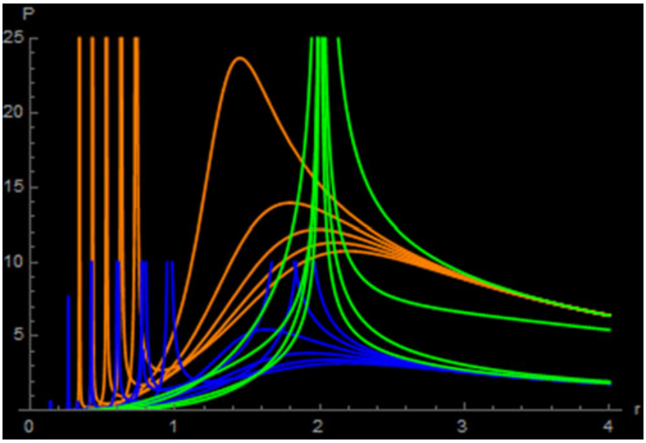

Figure 1. In the plot the green spectrum represents charge free AGN. The orange one represents low mass, low mean density galaxy where charge is being varied. Accordingly the higher peaks stand for higher charge value and so on. The blue spectrum represents high mass with reasonably higher mean density galaxy where charge is being varied.

the current standard ΛCDM cosmology that best fits to a number of various observations across a wide range of physical scales and cosmic time (Camera *et al.* 2018, Pellegrini *et al.* 2018, and the references therein). Moreover, a simple spherical geometry being superimposed with central disc structure is assumed by the cored void mass ablating model which still holds for the spherical symmetry.

3. Results and discussion

3.1. *Radial pressure*

With simplifying boundary conditions, we derived a conservation like generalized TOV equation that has been integrated to give the total radial pressure that depends on the parameters: q (the charge of the AGN, $M(r)$ (effective mass of the central AGN at r), $\rho(r)$ (density of the AGN surrounding fluid as a function of r), Λ (cosmological constant) and the core parameters (void mass, density, radius, height) given by:

$$P = \frac{[(\alpha\rho) + (q^2 + 16\pi r^4)\beta] \pm \sqrt{[\alpha\rho + (q^2 + 16\pi r^4)\beta]^2 - 512\pi^3\rho r^6\gamma\beta^2}}{16\pi r^2\gamma\beta} \tag{3.1}$$

where, α, β and γ are expressed in terms of the parameters mentioned earlier.

3.2. *Numerical results*

Using *Mathematica 11* we have generated a numerical result of the spectrum of pressure for some selected theoretically acceptable mass, mean density of the galaxy and void core parameters, as shown in Figure 1.

4. Conclusions

As we learn from the pressure spectrum plot and its equation, we draw the following points and comments.

a) The model developed here appears to be in agreement with what observations relatively tell us in terms of pressure distribution from the center of the hosting galaxy.

b) The AGN plays a role on hosting galaxy evolution, especially closer to it. Because as pressure creates turbulence to trigger rotations that can possibly enhance star formation where there is sufficient cold gas cloud system. In fact, the effect decreases with distance.

c) In confirmation with observations, we draw a conclusion that just next to the AGN the environment is quiet and hence no star formation expected.

d) The existence of net charge on the central gravitating system plays significant role in star formation.

e) We have also learned that Λ has no significant effect in AGN role against the host galaxy.

f) The void parameters of the AGN plays significant role in (its host) galaxy evolution.

g) The developed model shall be considered to describe AGN role in its host galaxy evolution. Moreover, it is our belief that the model also needs further developments to enrich for being more complete and comprehensive theory.

References

Camera, S., Fonseca, J., Maartens, R., & Santos, M. G. 2018, *MNRAS*, **481**(1), 1251

McKinnon, R., Vogelsberger, M., Torrey, P., Marinacci, F., & Kannan, R. 2018, *MNRAS*, 478(3), 2851

Pellegrini, S., Ciotti, L., Negri, A., & Ostriker, J. P. 2018, *ApJ*, **856**(2), 115

Yuan, F., Yoon, D., Li, Y.-P., Gan, Z.-M., Ho, L. C., & Guo, F. 2018, *ApJ*, **857**(2), 121