The Interplay among Black Holes, Stars and ISM in Galactic Nuclei
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Glimpses of reionization epoch by galactic black hole formation history

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Abstract. Recent detection of a large optical depth to Thomson scattering by Wilkinson Microwave Anisotropy Probe (WMAP) implicates in new considerations about reionization epoch. Nowadays it is possible to simulate hydrogen reionization for redshift $15 < z < 20$, although the greater difficult problem consists to know what are the first ionizing sources in the universe. Observations on Gunn-Peterson effect reconciled with WMAP findings suggests $z \sim 6$ as the redshift for complete reionization. Study on the formation history of supermassive black holes (SMBHs) in galaxies suggests an interplay among QSOs activity and star rate formation. On this aspect, QSOs work as clocks of star formation in spheroids. Observations of magnesium abundance in QSOs for various redshifts show that star formation in these systems began very early.

1. QSOs, SMBHs formation and first stars

Gas physics involved in the formation of SMBHs is still not well understood (Bromm & Loeb 2003). But is possible to do numerical simulations, specially hydrodynamical, to follow the development of self-graviting baryons in dark matter (DM) haloes in the creation of a galactic black hole. The Archibald *et al.*(2002) BH fueling for two initial seed mass ($10M_\odot$ and $1000M_\odot$ respectively), using the Friaça & Terlevich (1998) multizone code for spheroids, makes a number of predictions concerning the observability of high-redshift QSOs at different wavelengths, such as: *i)* QSO emerges ~ 0.5 Gyr after the onset of massive star formation in the galaxy halo; *ii)* For a formation redshift $z = 5$, a powerful QSO should therefore emerge at $z \sim 3.5$; *iii)* Conversely, the predicted ~ 0.5 Gyr time lag between the onset of massive star formation activity and appearence of a central QSO in this model can be used to infer the first epoch of massive star formation from the redshifts of the most distant QSOs. Assuming a QSO at $z = 7$, the model predicts that massive star formation commenced in its host galaxy at $z \sim 12 - 20$. As the CMB measured by WMAP requires a mean optical depth to Thomson scattering $\tau_e \sim 0.17$, the reionization redshift of the Universe must begun at relatively high redshift ($15 < z < 20$). This is an indication of significant star-formation activity at very early times. This is also confirmed by the observational analisys of chemical abundances, as in Figure 1, where we have one representation for line intensity FeII/MgII in QSOs from today to $z = 6.28$. Dietrich *et al.*(2003) claim for a star formation at $z \sim 9$. The metallicity studies of the QSO enviroments show that significant star formation in the host galaxies has occurred before the QSO-shining phase. Here QSOs work as chemical clocks: the QSO-shining phase begun as soon gas is accreted to the SMBH, affecting the Star Formation Rate (SFR) (Monaco *et al.*2000). Starbursts at high redshift envolved by dust can produce infrared radiation, detected by satellites as SCUBA as submillimetre sources. But there is a relative failure of X-ray surveys to detect bright SCUBA sources (Archibald *et al.*2002). What this indicate? Exactly that QSO activity produces inibition in star formation.

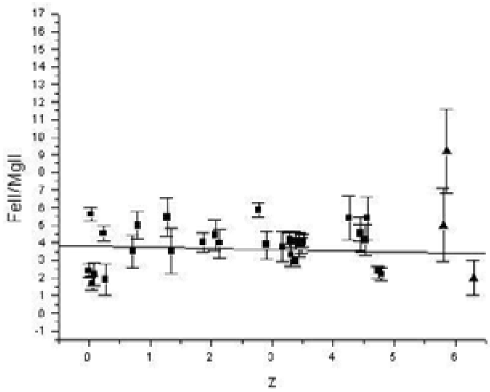

Figure 1. Relation FeII/MgII with the redshift. The fitting line is just to show the idea of relative constacy in abundances over various redshifts. Based on data reduced by Dietrich *et al.*(2003) (small squares) and Freudling *et al.*(2003) (triangles).

2. Reionization sources

We begin costructing the scenario where population III zero-metallicity stars are the first objects (cold dark matter hierarchical cosmogonies) and is expected to form in dark matter minihalos, condensing due to H_2 cooling from the high-σ peaks of the primordial density field at redshift $z = 20 - 30$ (Madau *et al.*2003; Bromm & Loeb 2003). There is some controversy if is really necessary very massive stars to ionizing the neutral hydrogen (Ciardi *et al.*2003). Others authors as Mandau *et al.*(2003) claim that population III stars form SMS at redshift ~ 25 and is necessary one top inicial mass function (IMF) to produce the desired Thomson optical depth. Nonrotating very massive stars will desappear ($140 < M < 260 M_\odot$) as pair instability supernovae, leaving no compact remnants and polluting the universe, as predicted by our suggestion. Stars with other order of mass will predicted to collapse to shine as miniquasars. Our future work consists in use the Friaça & Terlevich (1998) chemiodynamical code to obtain results upon evolution of reionization sources (as populations III stars, miniquasars or QSOs indeed).

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References

Archibald, E. N., Dunlop, J. S., Jimenez, R., Friaça, A. C. S., McLure, R. J., & Hughes, D. H. 2002, MNRAS, 336, 353

Bromm, V., & Loeb, A.2003, ApJ, 596, 34

Ciardi, B., Ferrara, A., & White, S. D. M. 2003, MNRAS, 344, L7

Dietrich, M., Hammann, F., Appenzeller, I., & Vestergaard, M. 2003, ApJ, 596, 817

Freudling, W., Corbin, M. R., & Korista, K. T. 2003, ApJ, 587, L67

Friaça, A. C. S., & Terlevich, R. J. 1998, MNRAS, 298, 399.

Madau, P., Rees, M. J., Volonteri, M., Haardt, F., & Oh, S. P. 2003, ApJ, submitted (astro-ph/0310223)

Monaco, P., Salucci, P., & Danese, L. 2000, MNRAS, 311, 279

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