# DETERMINATION OF Yp AND dY/dZ USING NEW CHEMICAL COMPOSITION OF PLANETARY NEBULAE AND HII REGIONS IN BLUE COMPACT DWARF GALAXIES.


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## Main goals:

- Determination of the chemical composition of HII regions in blue compact dwarf galaxies (BCDG) and planetary nebulae (PNe) using new ionization-correction factors (ICFs) obtained from calculation results of photoionization models grid.
- Determination of the chemical composition of HII regions in BCDG and PNe using optimized photoionization models (OPhM) calculation (non - ICFs method).
- Determination of the primordial helium abundance Yp and its enrichment dY/dZ during chemical evolution of matter using the chemical compositions of HII regions in BCDGs and PNe (see Poster of Havrylova et al.).

## Calculation of chemical composition using new ICFs.

*Main features of method*

- Calculation of photoionization models (PhM) grid of HII regions in BCDGs and PNe over following parameters: hydrogen density, filling factor, ionizing Lyman continuum (Lc) spectrum and heavy elements abundance (metallicity). We calculated two PhMs grids of PNe: 1) using radial gas distribution obtained by Golovaty V.V. et al. (1993) from analysis of isophotes of real PNe, 2)using random generated fluctuacions superimposed on distribution from point (1). We obtained Lc-spectrum for HII regions starburst knots using our method NLEHII which is independent on starburst characteristics. Lc-spectra for PNe nuclei were obtained from Clegg & Middlemass (1987) stellar athomosphere models corrected for stellar wind presence.
- Calculation of averaged ionic abundances from PhM predicted spectra using the same method wich was used for the determination of the ionic abundances in real objects. For this purpose we used our code DIAGN [1].
- Derivation of the new expressions for ICFs on the base of ionic abundances obtained by above method and chemical compositions used in corresponding PhM of grid.
- Testing of every ICFs expression for the reproduction of chemical composition given in correspondig PhM of grid.
- Calculation of ionic abundances in HII regions and PNe using DIAGN code and determination of the chemical composition in these objects using new ICFs.
- Determination of Yp and dY/dZ values from dependence of Y-Z obtained from chemical composition of HII regions in BCDGs and its enrichment dY/dZ from chemical composition of both type objects (HII regions and/or PNe).

## Optimized photoionization models of HII regions in BCDGs and PNe

- Selection of HII regions and PNe for OphM calculation. Selection criterion for HII regions: from the Y-Z dependence the most selected objects must reproduct the same Yp and dY/dZ values as chemical composition of all considered objects obtained using new ICFs. Selection criterion for PNe: presence of 4 HeI lines in oseravational spectrum.
- Calculation for every selected HII region Lc-spectrum using NLEHII method.
- Calculation of OPhMs. This technique is based on the minimization of $\chi^2$-function.
- Revision of values Yp and dY/dZ obtained by new ICFs using its comparision with previous ones values obtained from OPhMs.

## RESULTS:

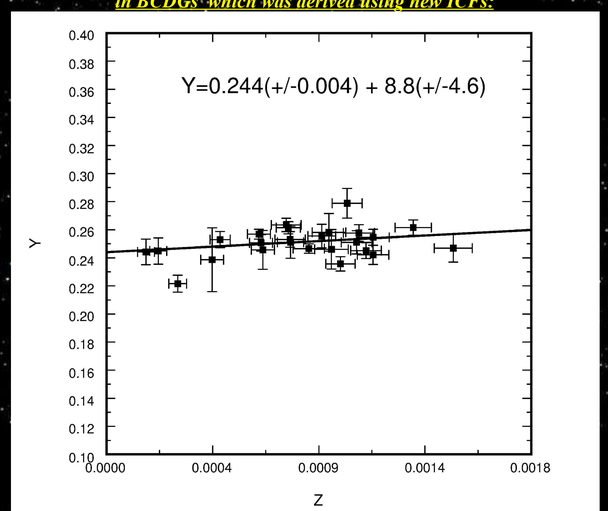
## Yp and dY/dZ values from HII regions in BCDGs chemical composition.

The values Y and Z were calculated using new ICFs by following expressions:

$$Y = \frac{4\mathrm{He/H}(1-Z)}{1+4\mathrm{He/H}}, \quad Z = \frac{Za}{1+4\mathrm{He/H}+Za}, \qquad (1)$$

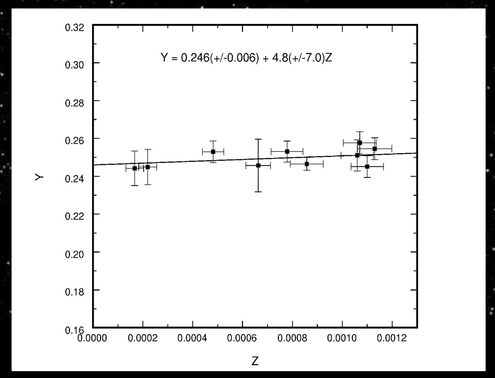
$$\mathrm{Za} = 14\ \mathrm{N/H} + 16\ \mathrm{O/H} + 20\ \mathrm{Ne/H} + 32\ \mathrm{S/H} + 40\ \mathrm{Ar/H}$$

***Dependence of Y-Z obtained from chemical composition of 24 HII regions in BCDGs which was derived using new ICFs:***




## How it can see Yp=0.244±0.004 and dY/dZ=8.8±4.6.

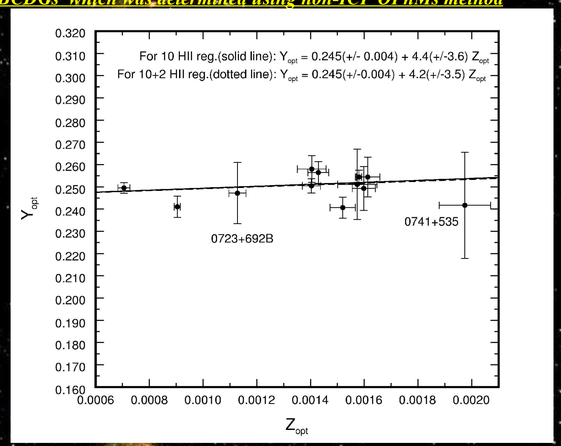
***Selection of HII regions for OPhM calculation:***




***The values Yopt and Zopt were calculated using OPhMs results by expressions (1), but value Za was calculated by following expression:***

$$Za = 14\ \mathrm{N/H} + 16\ \mathrm{O/H} + 20\ \mathrm{Ne/H} + 32\ \mathrm{S/H} + 40\ \mathrm{Ar/H} + 56\ \mathrm{Fe/H},$$

***Dependence of Y-Z obtained from chemical composition of 12 HII regions in BCDGs which was determined using non-ICF OPhMs method***

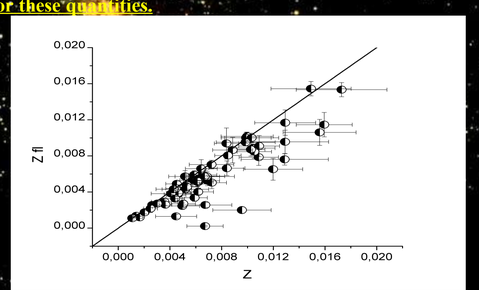



**Thus, from OPhMs calculation we obtained: Yp=0.245±0.004 and dY/dZ=4.2±3.5. OPhMs results of two additional objects (wich not correspond to above selection criterium) are added for the revision of solution stability.**

***We obtained coineidence in error bars of Yp and dY/dZ values determined from chemical composition of HII regions of BCDGs wich was derived by different methods (new ICFs and OPhMs).***

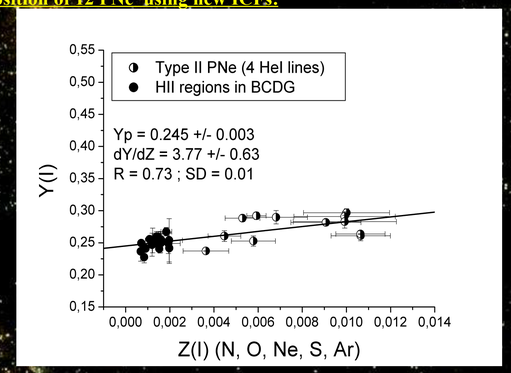
## Yp and dY/dZ values from HII regions and PNe chemical composition.

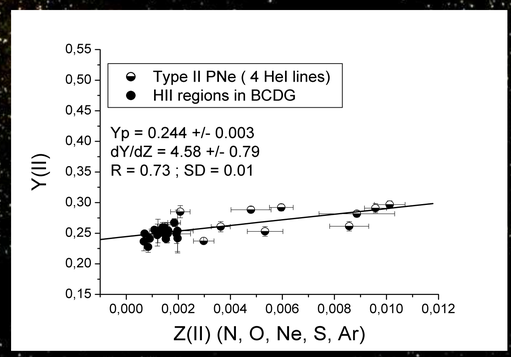
The values of Y and Z were calculated using expressions (1). In the following figure it is shown comparison of the heavy-elements abundances for type II of PNe (Z or Z(I) and Zfl or Z(II)) for two types of inhomogeneity (see Poster of N.Havrylova et al.) of the density distribution in their envelopes. The straight line corresponds to identical values for these quantities.



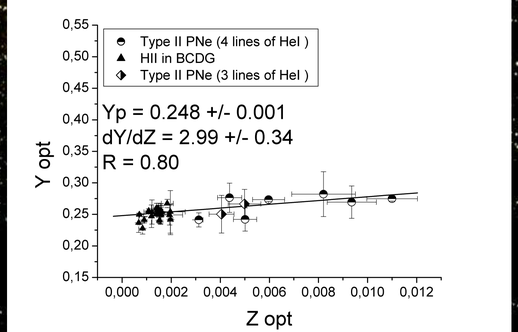

As it can see, presence of fluctuations (type II inhomogeneity) reduces the value of Z for most of the PNe.

**The Y(I) –Z(I) and Y(II) –Z(II) dependences for PNe type II (4 HeI lines) together with HII regions in BCDG for two types of inhomogeneity of the gas density distribution in their envelopes obtained using chemical composition of 12 PNe using new ICFs:**




***The Yopt-Zopt dependence for HII regions in BCDG combined with 9 PNe type II based on optimized photoionization models of these objects calculations.***




## CONCLUSIONS

- **The values of Yp and dY/dZ obtained by two different methods (new ICFs and OPhMs) from chemical composition of HII regions in blue compact dwarf galaxies and planetary nebulae coincide in error bars.**
- **The Y-Z dependeces obtained from combined HII regions + PNe chemical composition increase the determination precise of Yp and dY/dZ values in comparison to the previous ones values obtained only from HII regions in BCDGs data.**
- **Obtained values of Yp are close to the previous ones values obtained by Izotov and Thuan (1998).**


*Acknowledgements. The authors are grateful to Yu.I.Izotov (Main Astronomical Observatory, National Academy of Sciences, Ukraine) for useful discussions.*


## REFERENCES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2. Izotov, I.Yu., **Thuan, T.X. 1998, ApJ, Vol.500, P.188**