A STATISTICAL ANALYSIS OF QUASARS' REDSHIFT AND THE INCONSISTENCIES ASSOCIATED WITH LINE IDENTIFICATION

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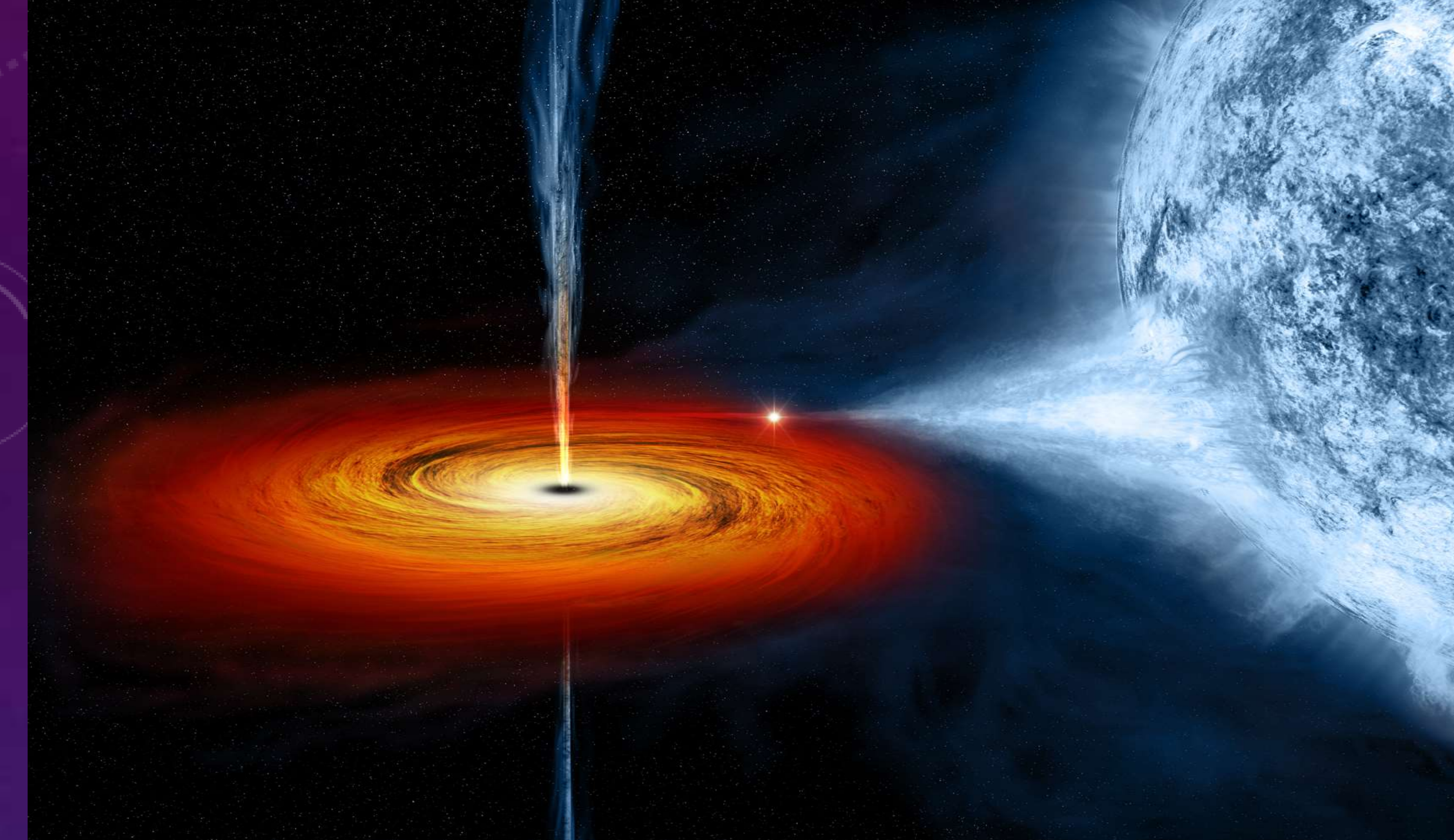
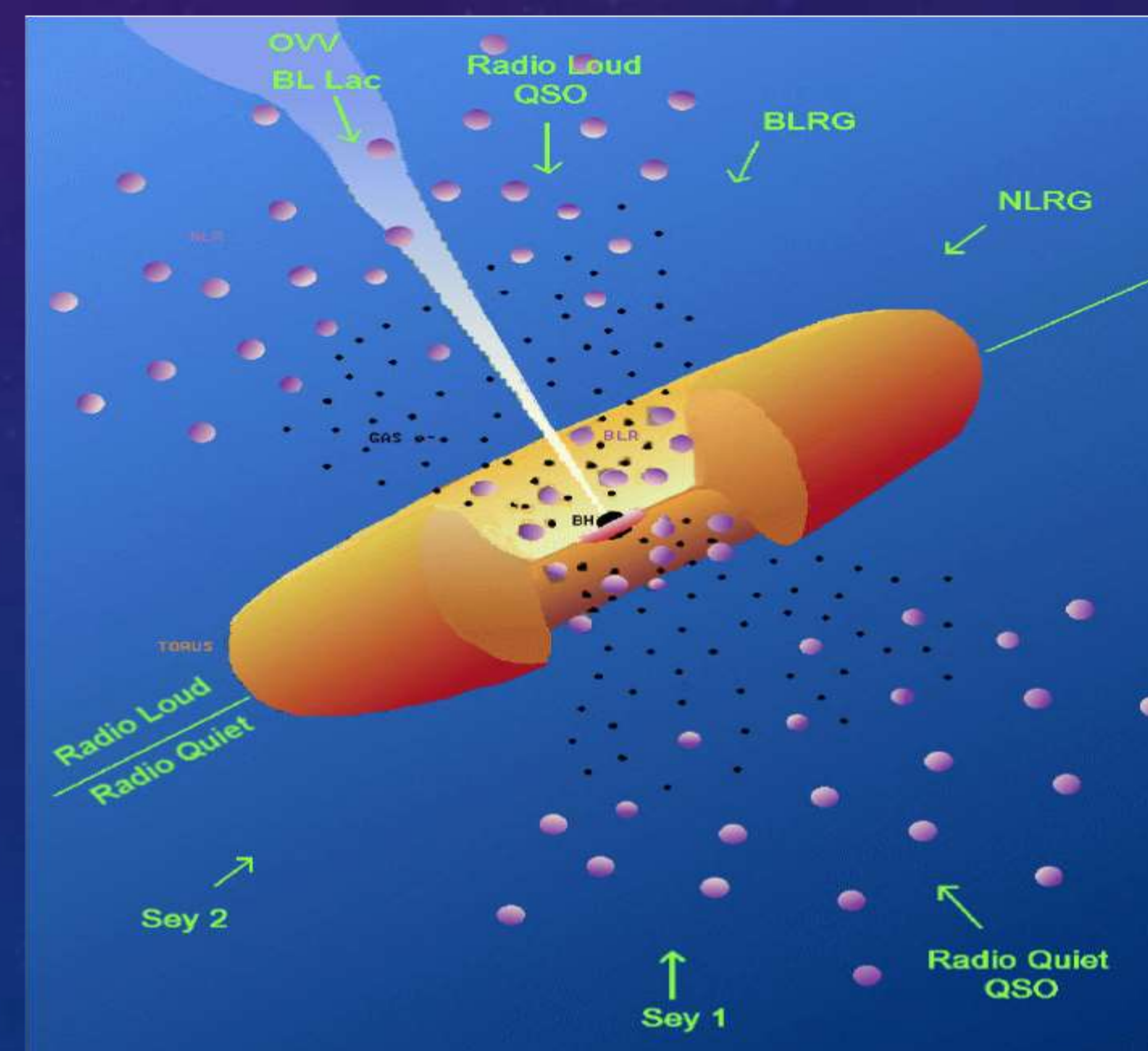
ABSTRACT: Quasars are a type of Active Galactic Nuclei that exists at large cosmological distances. This enables them to be windows to the early universe and therefore understanding their properties are important to our entire understanding of cosmology. Spectral lines have always been identified using a redshift interpretation that has produced some inconsistencies. These cases can also be examined using a blueshift interpretation. The aim of this research is to examine those quasars that cannot be aptly described by a consistent redshift to test if a possible blueshift may be more suitable interpretation by re-examination of the spectral lines. It is believed that this research will show at least a percentage of quasars with problematic redshift identification, can be better interpreted using blueshift. The sample was taken from the Million Quasars Catalog (MILLIQUAS), specifically the Unidentified class. This class was constrained for reported redshift values over 1 and then the samples were further refined to those that had spectra available. This gave 210 samples in total, with 20% so far being analysed using both the redshift and blueshift interpretation and the results were compared. Preliminary results show half of the quasar candidates are best identified under blueshift, with 20% having acceptable redshift spreads and 30% having too large a spread for both redshift and blueshift. This suggests that redshift is not the only viable explanation for spectra, nor is blueshift, but they work together as parts of a whole.



An artist's drawing a black hole named Cygnus X-1. It formed when a large star caved in. This black hole pulls matter from blue star beside it.
Credits: NASA/CXC/M.Weiss



A diagram showing how Active Galactic Nuclei can be seen as different Cosmological objects at different angles. Taken from Evan Schneider, 2011

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INTRODUCTION:

Image: NASA/CXC/VILLANOVA UNIVERSITY/J. NEILSEN

Black Holes come in a variety of sizes, but the ones that reside at the center of galaxies are known as supermassive black holes(SMBH). SMBH can get matter and gas pulled into their gravitational field, this results in the matter or gas orbiting around the SMBH and slowly spiraling into the center of the black hole, in this case it is called an Active Galactic Nuclei(AGN). A quasar is an AGN whose luminosity is so bright it outshines its host galaxy.

Quasars are millions and billions of lightyears away. Their distance is determined using spectral analysis. This spectra shows the presence of atoms by emission and absorption lines. These lines are shifted from their usual rest positions and the ratio of their difference gives redshift or blueshift depending on which end of the spectrum they are shifted. Things that move towards us are blueshifted and things that move away are redshifted. Typically, quasar spectra and spectra in general are assessed in terms of redshift only. Line identification of quasar spectra is programmed to match observed lines with lines on the red side of the spectrum, and therefore can only determine possible redshifts without considering blueshifts. (D. Basu, 2004) Line identification using the redshift interpretation has many inconsistencies and inaccuracies that are explained away but can be better suited with the blueshift interpretation, for at least some quasars.

METHOD AND RESULTS:

The data for this research was taken from the Unidentified class of the Million Quasars Catalog (MILLIQUAS) with the restriction of z >1. The dataset contains 210 quasar candidates and their photometric redshifts. The wavelengths of the observed lines within the spectra were identified using a combination of various Python modules and then the best fit of spectral lines with corresponding observed lines were attained using a created MATLAB code. The code utilized the formula $z = \frac{\lambda_0 - \lambda_e}{\lambda_0}$

where λ_0 is the observed wavelength and λ_e is the emitted wavelength at rest. The spectral lines used as search lines were a combination of the two lists: a list compiled D. Chojnowski using data from the National Institute of Standards and Technology and the list in Redshifts in Spectral Lines of Quasi Stellar Objects by D. Basu.

20% of this sample set was analysed to obtain their respective redshift values and redshift spreads. From this subset, it was seen shows that for some cosmic sources the spread of redshift values exceed the acceptable spread for redshift (0.01). There is also redshifts which give lines that do not correspond to their expected weights, such as Strong lines being identified as weak emissions and weak lines being assigned to strong emissions and some lines could not be identified using the redshift interpretation. These redshift values were cross-referenced with their reported redshifts as well, which highlighted the same inconsistencies.

An illustration of a quasar blasting a jet of hot, radioactive wind into the cosmos. (Image: © NASA, ESA and J. Olmsted (STScI))

RESULTS AND CONCLUSION:

Artist's concept showing how J043947.08+163415.7 – a very distant quasar powered by a supermassive black hole – might look close up. Image via ESA/Hubble/NASA/M. Kornmesser.

Using a similar MATLAB code, the same emission lines were analysed using a blueshift interpretation. The identified blueshifted lines showed a smaller spread value as well as a larger amount of emission lines being identified using this interpretation. From the subset analysed, 50% were better interpretated using the blueshift hypothesis, with only 20% being sufficiently interpretated using the redshift hypothesis. The remaining 30% had too large a spread under both hypothesis.

It can be concluded from this analysis that redshift values should be accepted with some degree of wariness and that the redshift hypothesis should not be outright accepted as the only interpretation of emission lines. This is not to say there is no cosmological redshift, but that the blueshift outweighs the redshift in some cases. Blueshift does not contradict redshift but should complement it.

References: Basu, D. 2004. "Unusual spectra observed in three QSOs: alternative interpretation in terms of blueshift." Physica Scripta.

Acknowledgements: Dr. Shirin Haque