Baryonic Matter at Supercluster Scales: new cluster candidate detected on Corona Borealis Supercluster

Carmen P. Padilla-Torres[1,3], Ricardo Génova-Santos[1], Jordi Cepa[1,4], Carlos M. Gutiérrez[1,4], Rafael Rebolo[1,2,4]

[1] *Instituto de Astrofísica de Canarias, 38200 La Laguna, Tenerife, Canary Islands, Spain.*

[2] *Consejo Superior de Investigaciones científicas ,CSIC, Spain*

[3] *Fundación Galileo Galilei - INAF , Spain-Italy ;* [4] *Dpto. de Astrofísica de la ULL, Canary Islands, Spain*

Fundación Galileo Galilei - INAF
Telescopio Nazionale Galileo

Abstract: **In a survey at 33 GHz for baryonic matter at large scales in the Corona Borealis Supercluster (CrB-SC) of galaxies (z=0.07) using the Very Small Array interferometer (VSA), covering 24 deg², we found two strong decrements in temperature. The one with a highest amplitude (hereafter CrB-H) was detected near the centre of the supercluster . The amplitude is –230±23 μK. There are no known clusters of galaxies coincident with the position of either of these decrements. To explain the origin of CrB-H, a combination of both CMB primordial perturbations and the Sunyaev-Zel'dovich (SZ) effect is required. We explore the possibility that this SZ effect could be produced by warm/hot gas on supercluster scales. ROSAT images do not show X-ray emission in these regions. We study the distribution of galaxies down to r ≤ 20 mag. Our analysis reveals in the region of CrB-H an overdensity of galaxies a factor two with respect to nearby control fields. We obtained spectroscopic redshifts for a subsample of these galaxies using SDSS-DR7 and AF2-WYFFOS at the 4.2m William Herschel Telescope (ORM, La Palma), and we have found evidence for a substructure in the spot region extending from z=0.07 to z=0.09. This suggests the presence of a new cluster and a filamentary structure on the line of sight of a length of tens of Mpc.**

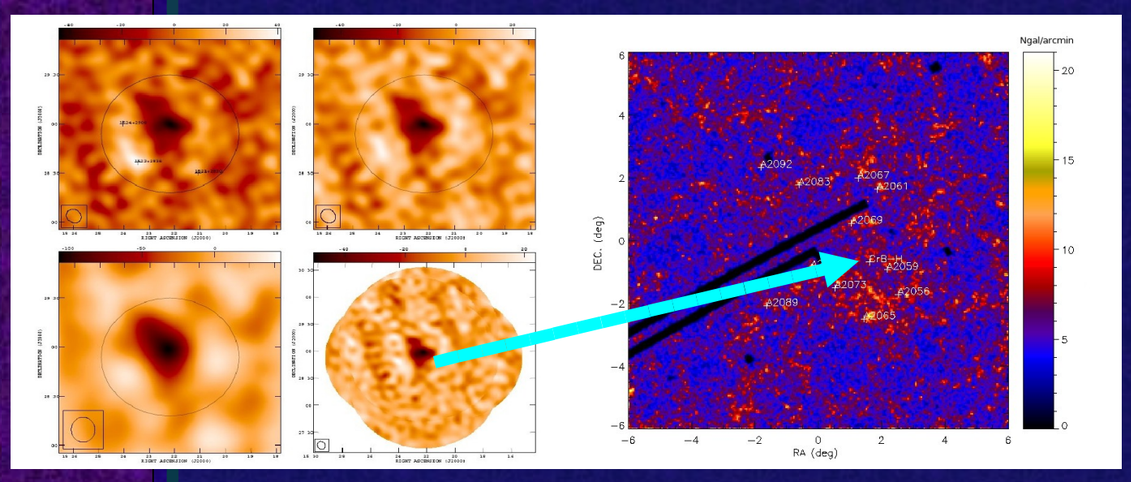


Fig1.-(Left) **VSA mosaic of the CrB-SC on the cold spot CrB-H region (Génova-Santos et al. 2008). The contribution of known point-like radio sources has been subtracted. The synthesized FWHM beam is shown in the bottom left corner (~7 arcmin). *(Right)* Using the SDSS-DR6 data we have generated the *galaxy* density map of CrB-SC (galaxies per arcmin² at magnitude r≤20). The total number of galaxies selected in the g, r, i bands and colours 0.2≤r-i≤0.6 was 19005. The arrow indicates the position (RA, Dec) (15ʰ 22ᵐ 11.47s +28⁰ 54' 06'') of CrB-H.**

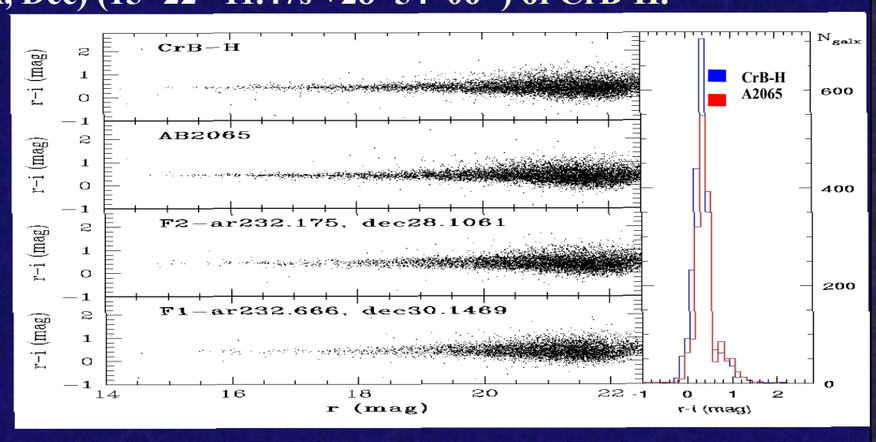


Fig 2.- **Colour-magnitude diagrams (CMD) in CrB-H, A2065, F1 and F2 (two control fields of CrB-SC) . On the right the colour r-i distribution is shown. There is a higher density of galaxies in CrB-H region with respect to control fields. This mostly corresponds to galaxies with colours 0.2<r-i<0.6.**

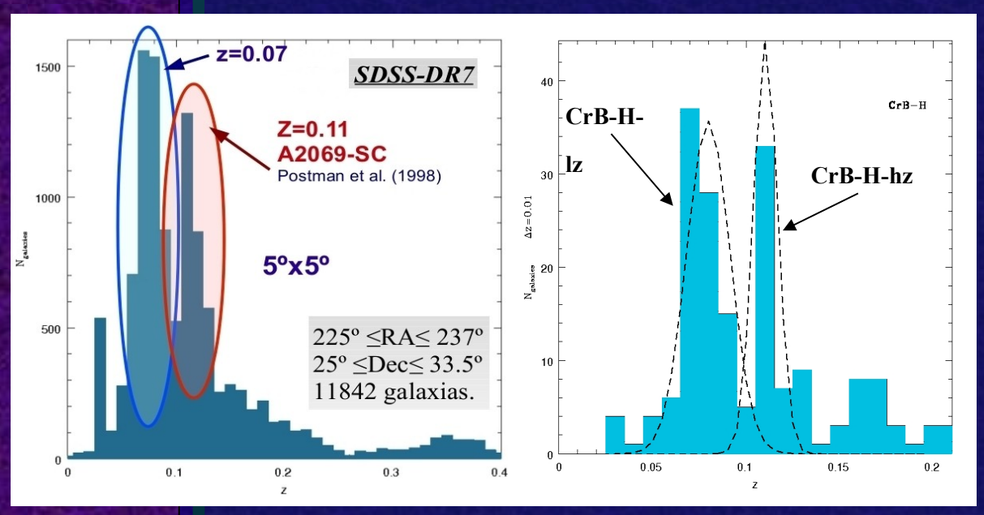
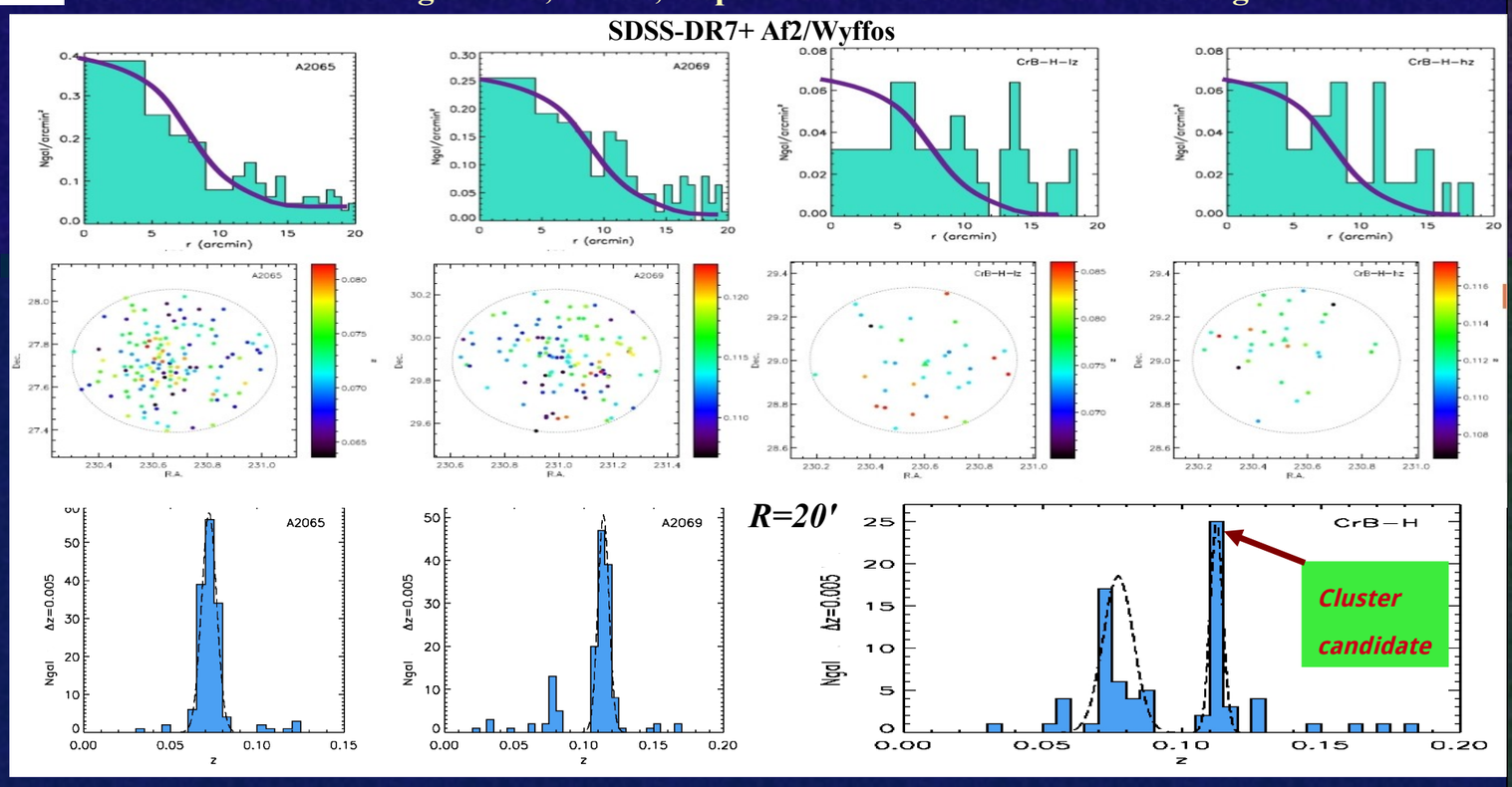


Fig 3.- **We have studied spectroscopic redshifts of CrB-SC galaxies, specially for a sample of them located in the area of the potential SZ spot with magnitudes in the range R=16-18.5 and colours consistent with the red sequence of the supercluster. *Left)* Measured redshifts for CrB-SC region. We can see two clear peaks; the most important one at z=0.07, and another one at z=0.11. They are associated with the galaxies belonging to CrB-SC and A2069-SC, respectively. (Right) Redshif distribution of CrB-H region galaxies. We can see the same two peaks at z=0.07 (CrB-H-lz), that could be representative of a filamentary structure, and z=0.11 (CrB-H-hz), being most prominent the first. The peak at z=0.11 could be representative of a new low-mass galaxy cluster in the CrB-H region and, in fact, responsible of ~13% of the SZ effect signal.**

Fig 4.- (Up) **Radial distribution of galaxies from A2065, A2069 and CrB-H (lz) and (hz) groups at z=0.07 and z=0.11 respectively *(Center) Spacial distribution of galaxy population from A2065,A2069 and CrB-H (lz) and (hz) (Bottom)* Redshift distribution of galaxies of A2065, A2069 and both groups CrB-H-lz (left) and the cluster candidate, CrB-H-hz (right).**



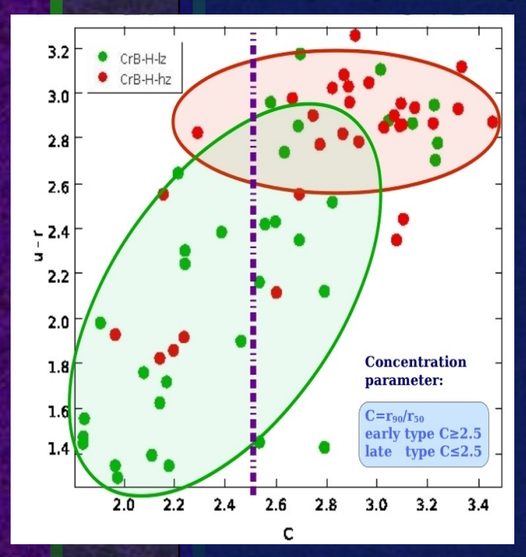


Fig 5.- **Morphological relation between the galaxy populations from CrB-H-lz and CrB-H-hz using the diagram [C,u-r]. We can see that the galaxies from CrB-H-hz are earlier than those from CrB-H-lz and also that the colour distribution of CrB-H-hz is less spread to (hz) than (lz). CrB-H-hz could be considered like a low-mass galaxy cluster candidate.**

Summary

Observations with the extended array of the VSA interferometer covering 24 deg2 of the CrB-SC region have detected two extended decrements, the most prominent one has an amplitude of –230±23 μK and position (RA, Dec) (J2000)=(15h 22m 11.47s +280 54' 06''). To explain CrB-H would require a combination of primordial CMB fluctuations and SZ effect. The analysis of galaxies in the SDSS shows the existence of an overdensity of galaxies coincident with CrB-H that could trace the warm gas in a filamentary structure in combination at a new cluster of galaxies at higher redshift in the line of sight.

We report the first results of a spectroscopic study using SDSS-DR7 and AF2-WYFFOS aimed at determining redshifts of a sample of galaxies in the region of CrB-H . The redshift distribution shows some overdensities around z = 0.07 (CrB-H-lz) and z=0.11 (CrB-H-hz). The DCM and morphological study of galaxies in CrB-H-hz favors the hypothesis of a linked and bound group of galaxies that represents a maximum a contribution of a ~13% to the signal detected by VSA, the galaxy population seems to have similar characteristics of the A2069-SC's galaxies. While the CrB-H-lz group is not seems being virialized, it could be a filament of a few tens of Mpc from 0.07≤ z≤0.09, with colours and morphological types similar to those we have found in A2065.

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