Astrophys Space Sci (2014) 349:437–442
DOI 10.1007/s10509-013-1601-4

ORIGINAL ARTICLE

More evidence for an oscillation superimposed on the Hubble flow

M.B. Bell · S.P. Comeau

Received: 28 May 2013 / Accepted: 10 August 2013 / Published online: 19 September 2013

Abstract In a recent investigation evidence was presented for a low-level sinusoidal oscillation superimposed on top of the Hubble flow. This oscillation was in V_{CMB}, in a sample of type Ia Supernovae sources with accurate distances, and it was found to have a wavelength close to 40 Mpc. It became easily visible after the removal of several previously identified discrete velocity components. Its amplitude like that of the Hubble velocity showed an increase with distance, as would be expected for a constant-amplitude space oscillation. Here we report that this oscillation is also present in distance clumping in these sources, with the same wavelength, but in phase quadrature. The discrete velocity components do not play a role in detecting the distance clumping wavelength. Assuming that time proceeds from high cosmological redshift to low, the blue-shifted velocity peaks, which represent the contraction stage of the velocity oscillation, then lead the density peaks. With the discrete velocity components removed we also find evidence for at least one other, weaker velocity oscillation. It is found to have a wavelength similar to one reported in density clumping by previous investigators. In those cases the source samples were much larger.

Keywords Galaxies: cosmology: distance scale · Galaxies: distances and redshifts · Galaxies: quasars: general

1 Introduction

Recently, using the SNeIa data from Freedman et al. (2001), where special precautions were taken to insure that the source distances were accurate, we have shown that there is evidence for a low-level oscillation superimposed on the Hubble flow that has a wavelength near 40 Mpc (Bell 2013). This result was obtained after determining and removing discrete velocity components of the form discussed by Tifft (1996, 1997), by us (Bell and Comeau 2003a, 2003b), and by Russell (2005a, 2005b, 2005c). Note that determining the discrete velocity components is only possible when the source distances are accurately known. Removal of these components resulted in a significant reduction in the RMS deviation in V_{CMB} from 780 to 166 km s^{-1}. Here we report that, in addition to the previously reported velocity oscillation, there is also evidence for density clumping visible in the distance distribution of SNeIa galaxies observed by Freedman et al. (2001). It too has a wavelength near 40 Mpc. This is not unexpected as Morikawa (1990) has pointed out that a density oscillation can be produced by a velocity oscillation superimposed on the Hubble flow. Unlike the velocity oscillation, the density clumping is in distance and the discrete velocity components do not play a role in its detection. We also search here for other velocity periods present in the SNeIa data after the discrete components are removed. We show in Sect. 4 that not only does at least one other, weaker velocity period become visible after the discrete components are removed, it has a period similar to that found in density clumping by other investigators. Throughout this paper the term *contraction stage* refers to the blue-shifted portion of the velocity oscillation.

2 Evidence for density clumping

In Fig. 1 the distances of the SNeIa sources are plotted at level 1. The curve in Fig. 1 shows a smoothed distribution of the data obtained by taking a running source count using

M.B. Bell (✉) · S.P. Comeau
National Research Council of Canada, 100 Sussex Drive, Ottawa, ON K1A 0R6, Canada
e-mail: morley.bell@nrc-cnrc.gc.ca