The shape and profile of the Galactic Halo as seen by the CFHT Legacy Survey

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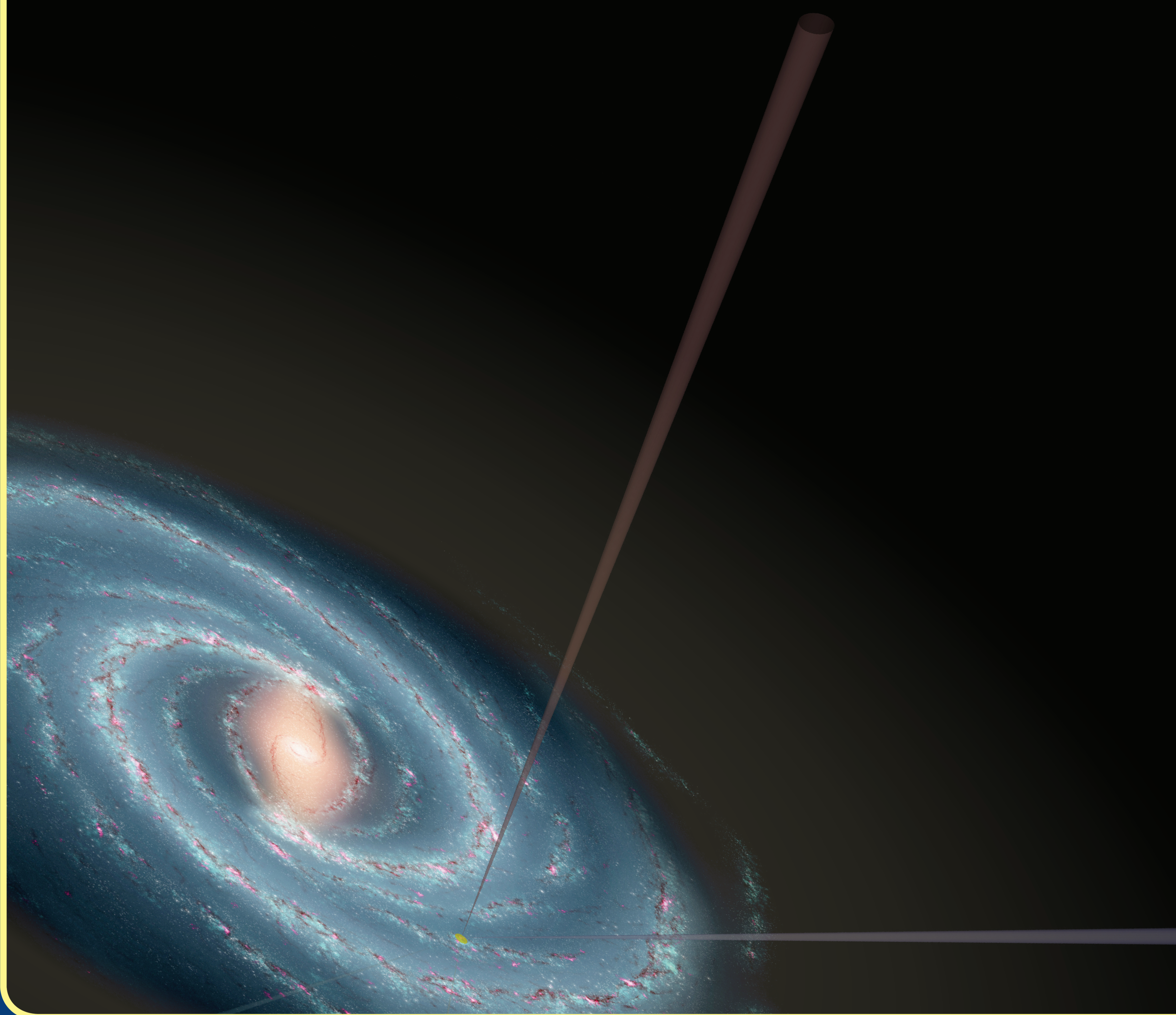
The halo stellar number density profile constrains the contribution of massive mergers to the formation of the Milky Way halo. Using the CFHT Legacy Survey data, we measure this profile to heliocentric distances of up to 35 kpc and find that it becomes steeper beyond 28 kpc, without a significant change of its oblate shape. We do not detect any gradient in the photometric metallicity over the probed distance range. Our results are consistent with SDSS-based results for smaller heliocentric distances.

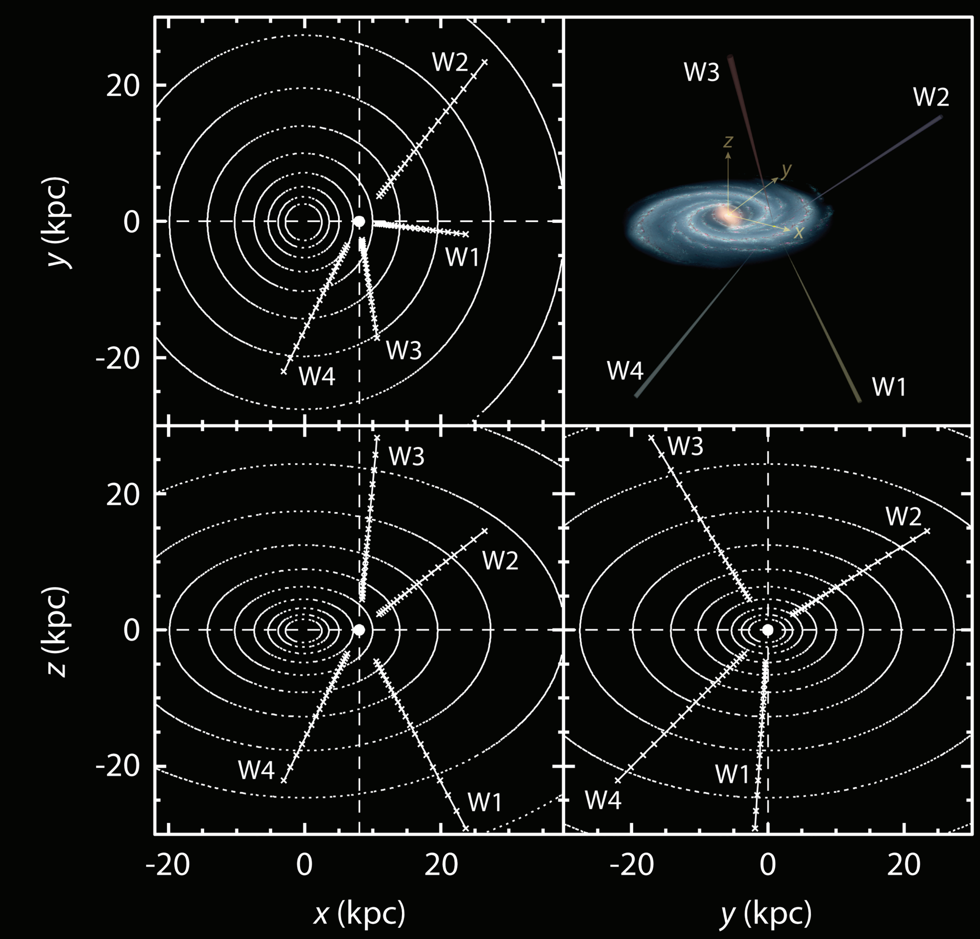


Using main sequence stars, Jurić et al. (2008) have found that the stellar halo density distribution within 15 kpc of the Sun can be fit with a two parameter, single power-law ellipsoid model

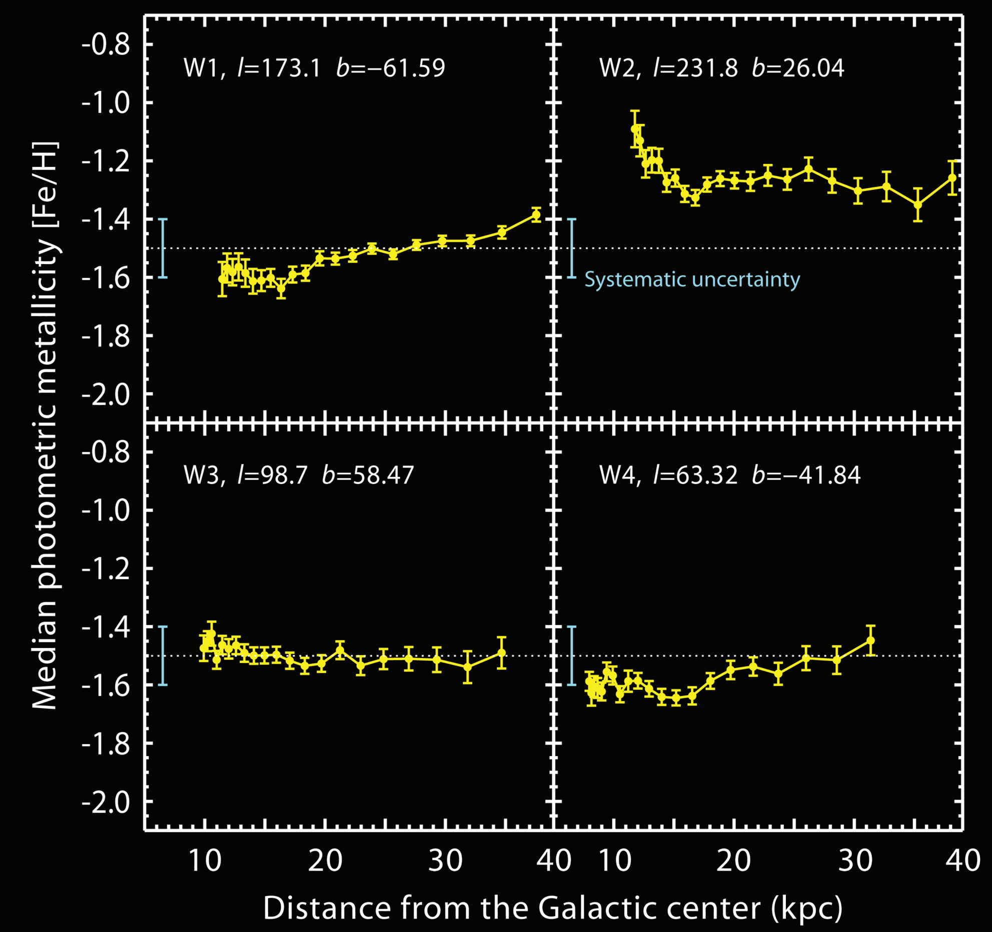
$$\rho(R,Z) \propto \left[R^2 + (Z/q)^2\right]^{n/2},$$

where R and Z are cylindrical galactocentric radius and height above the Galactic plane, $n = -2.77 \pm 0.2$ is the power law index, and $q \equiv c/a = 0.64 \pm 0.1$ is the ratio of major axes in the Z and R direction, indicating that the halo is oblate (flattened in the Z direction). However, additional data suggest that the Jurić et al. (2008) single power law halo cannot be extrapolated beyond 15 kpc.

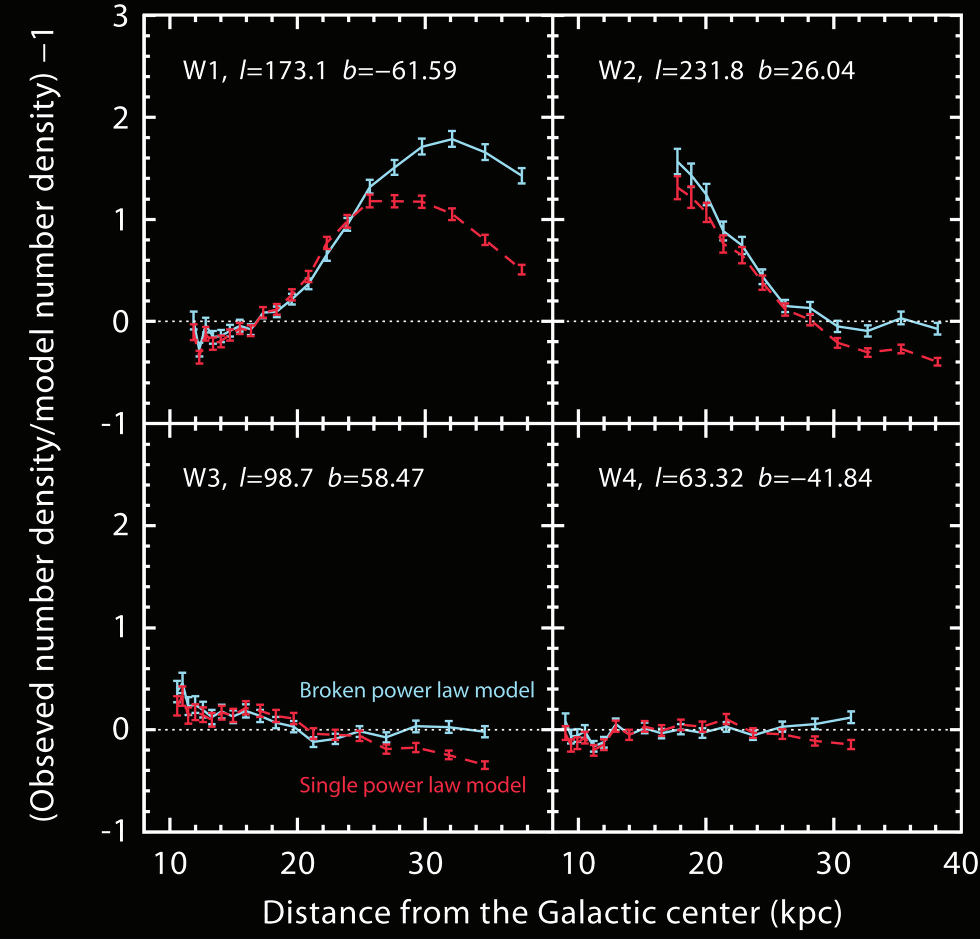
We use Canada-France-Hawai`i Telescope Legacy Survey (CFHTLS) data for 170 deg^2, recalibrated and transformed to the Sloan Digital Sky Survey *ugri* photometric system, to study the distribution of near-turnoff main sequence stars in the Galactic halo along four lines of sight, to heliocentric distances of ~35 kpc. The CFHTLS lines of sight are described on the right, and our findings are detailed below.



Visualization of CFHTLS Wide Survey beams.
The projection of CFHTLS beams onto *x-y*, *y-z*, and *x-z* planes, where *x*, *y*, and *z* are axes of a right-handed galactocentric Cartesian coordinate system (the Sun is at $[x,y,z] = [8,0,0]$). The isodensity contours show the stellar halo number density model from Jurić et al. (2008).



No evidence for a halo metallicity gradient.
The median photometric metallicity (symbols with error bars) measured in four CFHTLS Wide survey beams as a function of distance from the Galactic center. The error bars show error in the median and the error bar at (6.5, −1.5) shows the systematic uncertainty in the adopted photometric metallicity method (~0.1 dex, Ivezić et al. 2008). Within ~30 kpc, the median metallicity is independent of distance and ranges from $-1.4 <$ [Fe/H] < -1.6. The change in metallicity at ~15 kpc, reported by Carollo et al. (2007) and de Jong et al. (2010), is not evident. Apparently higher metallicity in the W2 beam ([Fe/H] ~ −1.3 dex) may be due to *u* band calibration issues.



Halo density profile steepens beyond ~28 kpc.
A comparison of observed and model stellar halo number densities for the single power law Jurić et al. (2008) model (red dashed line) and the broken power law model proposed in this work (blue solid line). In the broken power law model, the halo is oblate ($q = 0.70 \pm 0.01$) and the number density profile becomes steeper at distances greater than ~28 kpc from the Galactic center, with the power law index changing from $n_{inner} = -2.62 \pm 0.04$ to $n_{outer} = -3.8 \pm 0.1$. Greater-than-modeled number density in W1 (top left) and W2 (top right) beams are due to the Sagittarius and Monoceros streams, respectively. Beyond ~35 kpc, the broken power law model provides a much better fit to the data than the single power law model. For example, the single power law model overpredicts the number density by > 50% in W2 and W3 beams at distances greater than ~35 kpc.