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# Ahormalous Extraction towards NGC 1938 (De Marchi et al. 2020)

### Abstract

Intrigued by the extended red-giant clump (RC) stretching across the colour–magnitude diagram of the stars in a  $50 \times 50$  pc<sup>2</sup> region of the Large Magellanic Cloud (LMC) containing the clusters NGC 1938 and NGC 1939, we have studied the stellar populations to learn about the properties of the interstellar medium (ISM) in this area. The extended RC is caused by a large and uneven amount of extinction across the field. Its slope reveals anomalous extinction properties, with  $A_V/E(B-V) \simeq 4.3$ , indicating the presence of an additional grey component in the optical contributing about 30% of the total extinction in the field and requiring big grains to be about twice as abundant as in the diffuse ISM. This appears to be consistent with the amount of big grains injected into the surrounding ISM by the about 70 SNII explosions estimated to have occurred during the lifetime of the  $\sim 120\,\mathrm{Myr}$  old NGC 1938. Although this cluster appears today relatively small and would be hard to detect beyond the distance of M 31, with an estimated initial mass of  $\sim 4\,800\,\mathrm{M}_\odot$  NGC 1938 appears to have seriously altered the extinction properties in a wide area. This has important implications for the interpretation of luminosities and masses of star-forming galaxies, both nearby and in the early universe.

Subject headings: dust, extinction — stars: formation — galaxies: stellar content - galaxies: Magellanic Clouds - galaxies: star clusters — open clusters and associations: individual (NGC1938) — globular clusters: individual: (NGC1939)

## Points

MEC 1939 ... an old globular cluster/MEC 1938 ... young cluster (age & 400 Myr) DEC 1938の間倒でもpataly な exthation があると意味しいる. Red Clumpの型がさきざまな、extinctionを当ける > extinction vector が見る

#### Observations

Hubble Space Telescope/Wide Field Comera (F555W & F814W) (Initing magnitude ~ 25 mag. (ePSF photometry) 18、1 (F555W), 13.4 (F814W) おりも明るい天体日補正して剥怅

#### Kesuts

MEC 1939: patchy to extinction to Ettritoin & E(V-I) = 0.16 (~ foreground Galactic extinction)

NGC 1938: broad to main sequence ... patchy to extinction n界线管

120 Myr & E(V-I) = 0.39 の isochrone でもく一致する (additional E(V-I)=0.26)

Control: 1.5-4 Gyr a isochrone 2"&C&S (LMC werage ~ 2 Gyr)

Red Clump si' trail to 31 in 2 in 3 (~ patchy extinction)

extinction vector は Rr~4.3 相当/全体に対に30% ほどgray to dust の 寄午が 示唆社る

- 30 Por 村近の extinction low と ほぼ同じ

#### Discussion

若の星田で大きなRutを示すことはあるか? — Yes, Orion Nebula Cluster, Tourns, Cep OB3b などで知られている 一方で、これらは molecular cloud でのおえト成長が生業回と生れるいる NGC (938 ~ 年齢ではこの効果は期待できない (?)

30 Dor でも同様の extinction law が観到

type-II SNTe におって a > 0.05 µm よりもたきいがわれが新たに供給された説がある(De Marchi & Panagla, 20(9)

NGC 1938で性じた SNe でドスト量を試明できるか?

この分野地的 median extinction は Ar~0、36 mag. ~30% 11 blg ghoin n \$5: Ar ~ 0.1 mag. column dousity by n= Tr/T ~ 2.1 x (08 cm² 铜喇儿传到达50户次50户飞"灯=5.1×1048 2,又g 0m3 E1度定すると 14~4,2×1034g~21 140

extinction si gray tono U.55 µm = 2TCB, Q~0,09 µm, CMD +D 現在NGC 1938 に食まれる 3-4 Mo の屋は ~於天体. standard IMFを仮定して extrapolate おると >8Mon 里日 ~66天体. 1天体またりの3Mon big grainを供給すると、66×0、3~19、8Mo オーダとにる客とない。

comp. field isochrones of 1.5, 2, 3.4 Eur  $m_{555} - m_{814}$  $m_{555} - m_{814}$ 

FIG. 2.— CMDs of high-quality stars in different parts of the field. In Panel a) all high-quality stars are included. In Panel b), small grey dots are used for stars within a radius of 5.5 pc of the centre of NGC 1939, while thick black dots mark objects within 2.5 pc of it. In Panel c), small grey dots indicate stars within 5.5 pc of the centre of NGC 1938 and thick black dots those within a 1.6 pc radius. The solid line shows a 120 Myr isochrone from the models of Marigo et al. (2008) for the appropriate metallicity and distance, and combined colour excess (foreground + intrinsic) of E(V-I) = 0.39. The CMD in Panel d) is obtained from all stars contained in the top half of Figure 1. Theoretical isochrones from the models of Marigo et al. (2008) for metallicity Z = 0.004 and ages of 1.5, 2, , and 4 Gyr are shown, respectively, in green, red, orange, and blue. In all panels the thin horizontal lines indicate the saturation level discussed in Section 2.

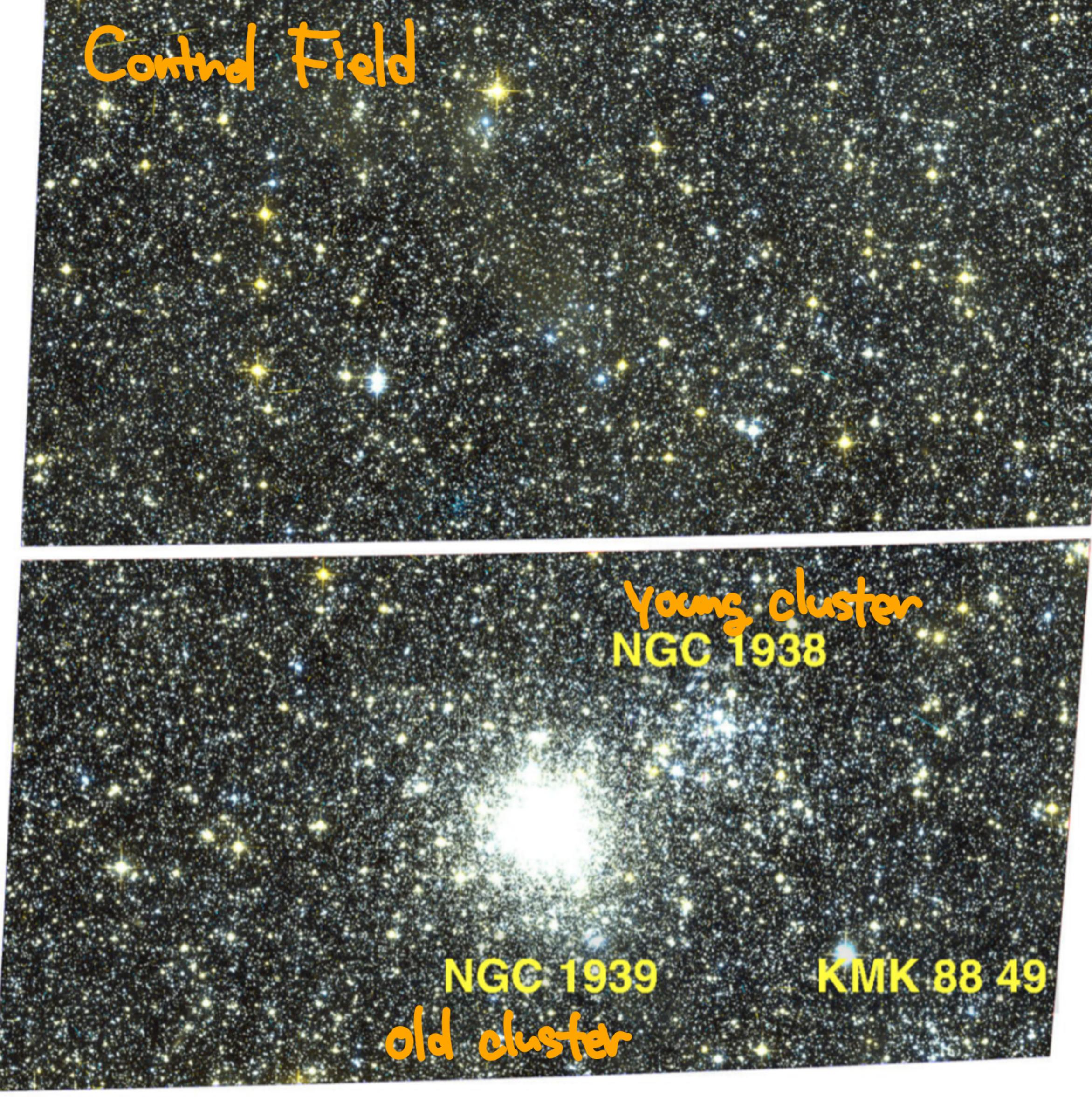


FIG. 1.— Colour composite image of the region obtained by combining the exposures in the F555W and F814W bands. The field spans approximately 205'' or  $\sim 50\,\mathrm{pc}$  on a side. North is inclined  $44^\circ$  to the right of the vertical, with East to the left of North.

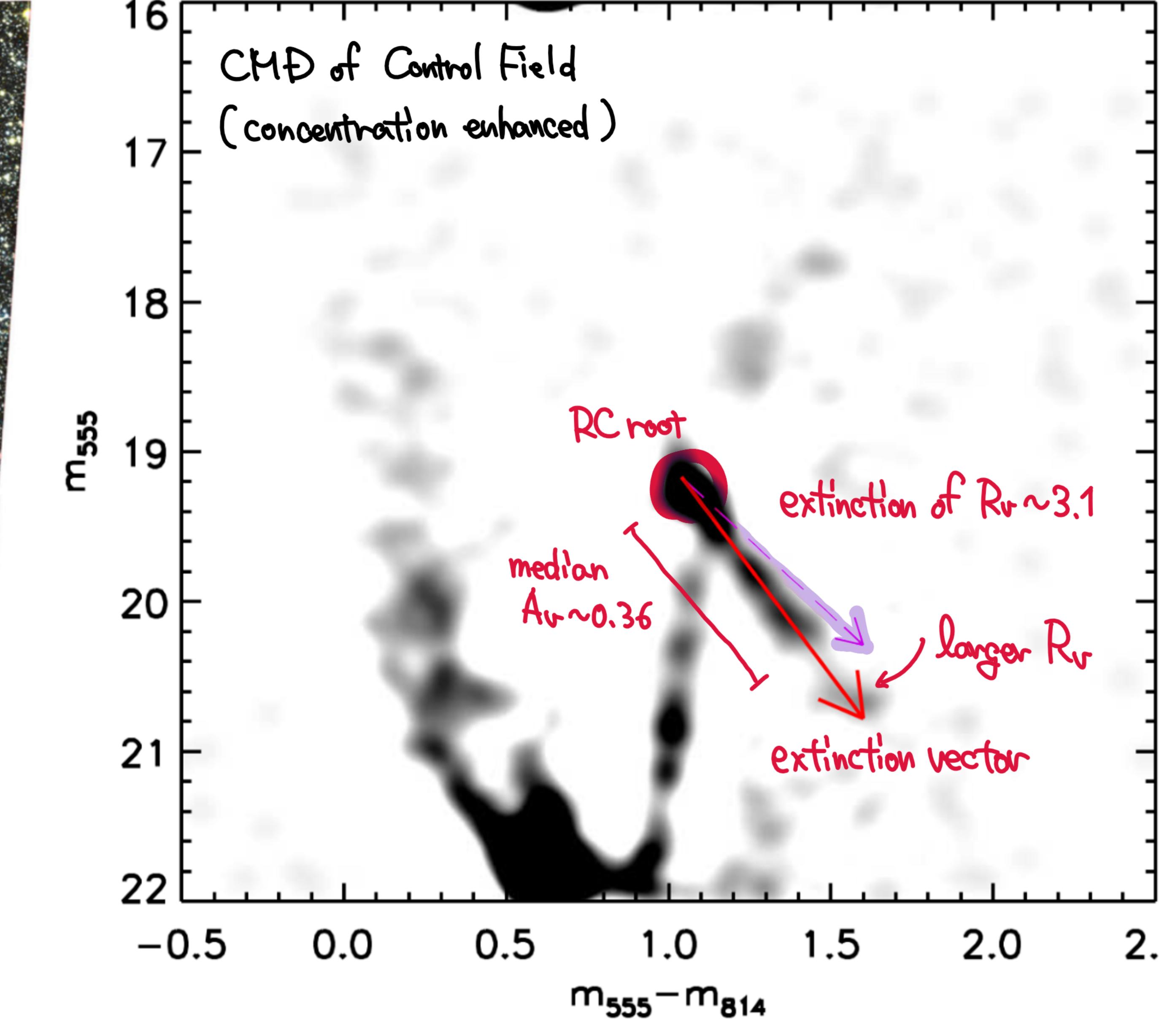


FIG. 3.— Same CMD as in Figure 2d after unsharp masking. The thick arrow marks the ridge along the elongated RC, while the thin dashed arrow shows the direction of the reddening vector in the diffuse ISM, corresponding to  $R_V = 3.1$ .

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