Extinction studies in the Local group galaxies conducted by Bulgarian astronomers

Petko Nedialkov[1] & Viacheslav Klimenko[2]

[1]University of Sofia, Bulgaria; [2]University of South Carolina, United States

GEORGE DIMITROFF

Born 24 August 1901
Svishtove, Kingdom of Bulgaria
Died 01 January 1968 (aged 66)
Hartland, Vermont, U.S.
Citizenship Bulgaria, United States (1930-1968)

Education
Robert College (1917-1920)
High school in Constantinople (Istanbul), Turkey

Boston University (1921-1927)
Massachusetts, United States

MS from Harvard university (1931)
PhD from Harvard university (1937)
Thesis Atmospheric extinction

Scientific career
Physics teacher at Colorado State College (1929-1934)
Physics teacher at Radcliffe College (1934-1937)
Research associate in astronomy at Harvard university
and Superintendent of the Oak Ridge, Mass., station of
the Harvard observatory (1937-1942)
Professor at Dartmouth College (1946 -1966)

Known for
Building some of the largest Schmidt lens telescopes before the one at the Mount Palomar
Advising the Mexican Government on
Building the observatory at Puebla, Mexico
Undertaking scientific mission in Europa and Japan as a commander in the Navy in WW II

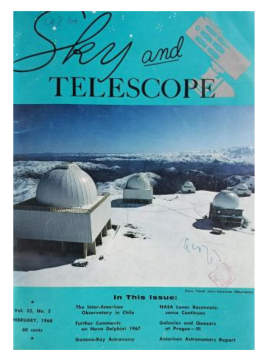
Publication list (Astrophysics Data System)
15 publications in total
2 papers on Atmospheric extinction available

Not to be mistaken with Georgi Dimitroff – Bulgarian communist leader, general secretary of the Communist international in Moscow (1935 –1943)

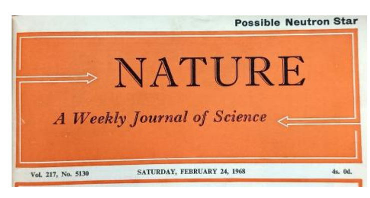
George Dimitroff, Harvard (1939)
Credits: Buzzoni et al. (2023)
doi 10.12871/978883339843321

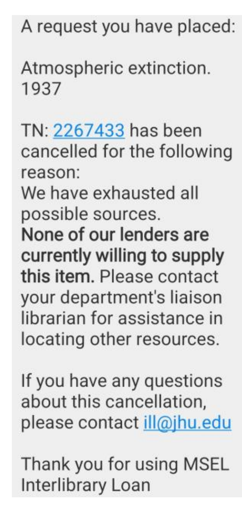
George Dimitroff, Dartmouth (60's)
Credits: https://archive.dartmouth-alumnimagazine.com

Books
General Physics For The Laboratory [1930]
Telescopes And Accessories
(w James G BAKER) [1945], cited 19 times
Astronomy In Brief [1956]



Obituaries
Nature
Sky & Telescope
The New York Times

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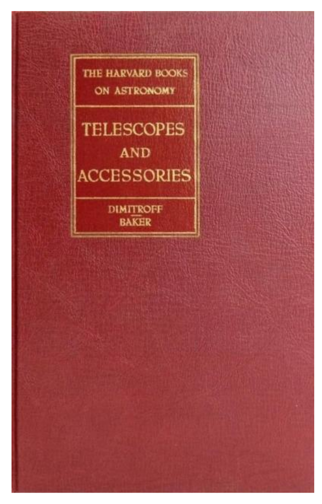
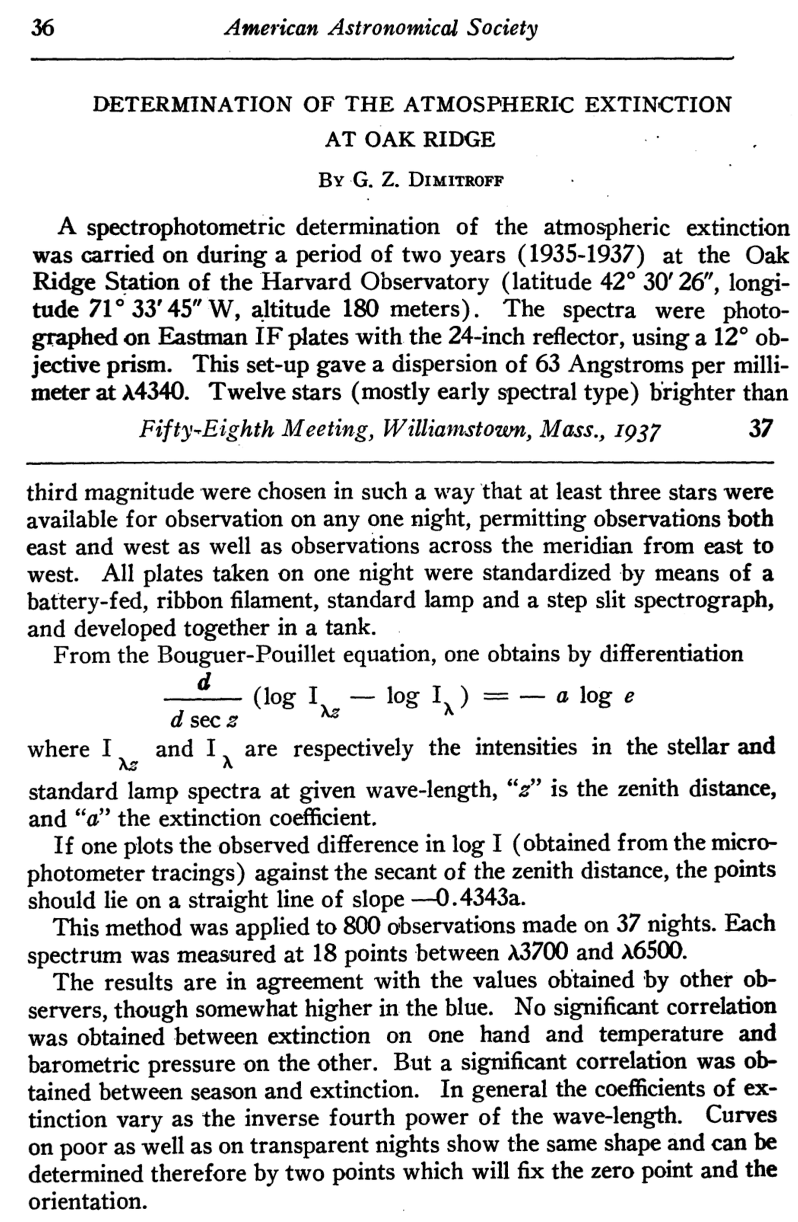



36 *American Astronomical Society*

DETERMINATION OF THE ATMOSPHERIC EXTINCTION AT OAK RIDGE

By G. Z. Dimitroff

A spectrophotometric determination of the atmospheric extinction was carried on during a period of two years (1935-1937) at the Oak Ridge Station of the Harvard Observatory (latitude 42° 30′ 26″, longitude 71° 33′ 45″ W, altitude 180 meters). The spectra were photographed on Eastman IF plates with the 24-inch reflector, using a 12° objective prism. This set-up gave a dispersion of 63 Angstroms per millimeter at λ4340. Twelve stars (mostly early spectral type) brighter than

Fifty-Eighth Meeting, Williamstown, Mass., 1937 37

third magnitude were chosen in such a way that at least three stars were available for observation on any one night, permitting observations both east and west as well as observations across the meridian from east to west. All plates taken on any one night were standardized by means of a battery-fed, ribbon filament, standard lamp and a step slit spectrograph, and developed together in a tank.

From the Bouguer-Pouillet equation, one obtains by differentiation

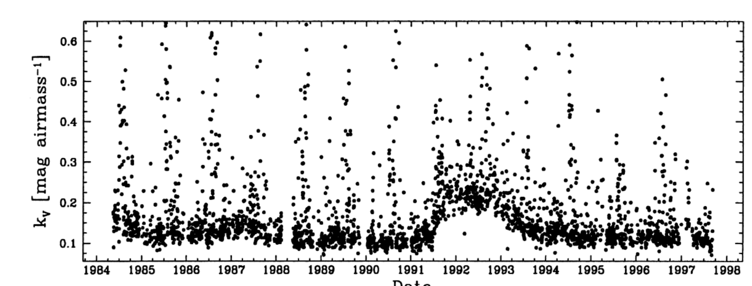
$$\frac{d}{d\sec z}(\log I_{\lambda z} - \log I_{\lambda}) = -a \log e$$

where $I_{\lambda z}$ and I_{λ} are respectively the intensities in the stellar and standard lamp spectra at given wave-length, "z" is the zenith distance, and "a" the extinction coefficient.

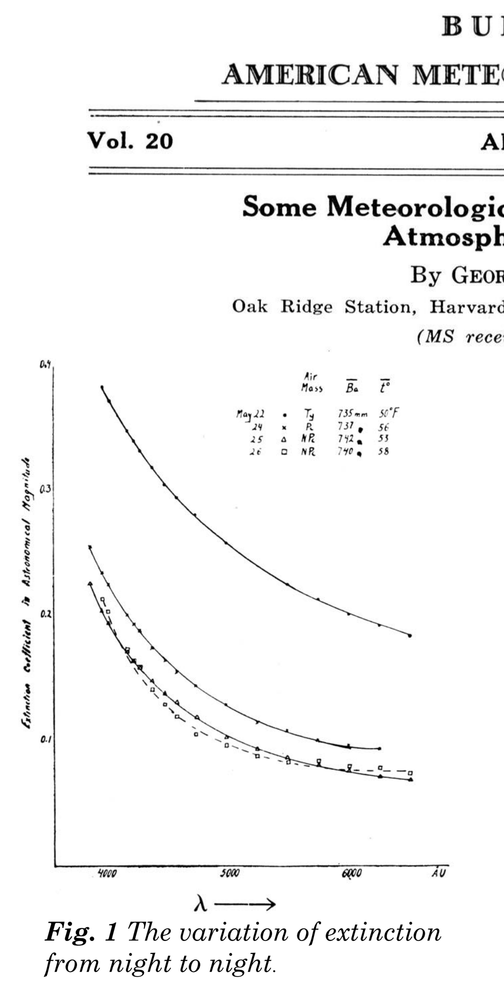
If one plots the observed difference in log I (obtained from the microphotometer tracings) against the secant of the zenith distance, the points should lie on a straight line of slope −0.4343a.

This method was applied to 800 observations made on 37 nights. Each spectrum was measured at 18 points between λ3700 and λ6500.

The results are in agreement with the values obtained by other observers, though somewhat higher in the blue. No significant correlation was obtained between extinction on one hand and temperature and barometric pressure on the other. But a significant correlation was obtained between season and extinction. In general the coefficients of extinction vary as the inverse fourth power of the wave-length. Curves on poor as well as on transparent nights show the same shape and can be determined therefore by two points which will fix the zero point and the orientation.



Chronological variation of the extinction coefficient in the V-band, k_V, over La Plama observatory, Canary islands. The observations span from 1984 to 1997. The effect of the Mt. Pinatubo eruption (1991) is clearly visible. Credits: Fig. 1 in Guerrero et al. , 1998, New Astronomy Reviews 42, 529.


BULLETIN OF THE AMERICAN METEOROLOGICAL SOCIETY

Vol. 20 APRIL, 1939 No. 4

Some Meteorological Factors Related to the Atmospheric Extinction

By George Z. Dimitroff

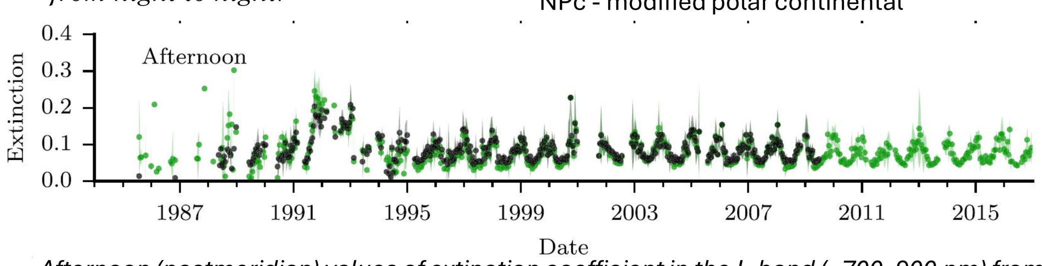
Oak Ridge Station, Harvard College Observatory, Harvard, Mass.

(MS received Mar. 29, 1939)

Fig. 1 The variation of extinction from night to night.

Fig. 1 is a sample of the average values of the extinction coefficient (given in astronomical magnitudest), for different wave lengths, obtained on four nights in 1935. The variation in the coefficient of extinction from night to night is apparent at a glance, but these variations become more significant when we note the character of the air mass for the respective nights. On May 22, there prevailed over New England a warm and moist Tropical Gulf (TG) air mass with a corresponding extinction coefficient 0.1 to 0.2 of a magnitude higher than on the nights on which polar continental (Pc) and modified polar continental (NPc) mass prevailed.

Prevailing air mass:
Tg - warm and moist Tropical Gulf
Pc - polar continental
NPc - modified polar continental



Afternoon (postmeridian) values of extinction coefficient in the I_c band (~700–900 nm) from Carnarvon, Western Australia obtained with transmission (black dots) and scatter detector (green dots) over 30 years of solar data. Credits: Fig. 4 in Hale et al., 2017, AJ, 154, 89.

Usually, it is taken for granted that I am the 'mad Russian'. I must, however, disappoint you because I was born in Bulgaria. During the IAU meeting in Dublin I was at a party when a lady came to the host and said 'So there are only two Russians at the party tonight! I have met Dr Dimitroff and should like to meet the other.' When told that Dr Dimitroff is not a Russian she sighed 'What a pity ! I have to start all over again.'

Dimitroff, G. Z., 1956, Journal of the British Astronomical Association, 66,184

"Dr. Dimitroff went to the Soviet Union in 1958 as a member of the International Astronomical Union and returned there in 1963 on a world tour of observatories. Impressed with the Soviet scientific advances, he predicted then that the Soviet Unionin 20 years would be the leading scientific nation."

The New York Times Obituary

PETKO NEDIALKOV

Born 1963
Pleven, Bulgaria

Citizenship Bulgaria

Education
Mathematical high school in Pleven, Bulgaria (1978-1981)
Sofia University (1983-1988)
MS from Sofia University (1988)
PhD from Sofia University (1998)
Thesis Observational manifestation of the extinction in disks of spiral galaxies

Scientific career
Physicist at Kircali observatory (1988-1994)
Physicist at Department of Astronomy, Sofia university (1994 - 1998)
Assist. Professor at Department of Astronomy, Sofia university (1999 - 2004)
Assoc. Professor at Department of Astronomy, Sofia university (since 2004)

Publication list (Astrophysics Data System)
152 publications in total
11 Extinction papers in ADS
5 Extinction papers outside ADS

ADS:

1. The inclination effect of spiral galaxies on their fundamental observational characteristics
Nedyalkov, 1993, AstL, 19, 115.

2. On the Absorption of Light from the Brightest Stars in M 31
Nedialkov & V. Ivanov, 1999, A&AT, 17, 367

3. Star Formation History and Extinction in NGC 206
Veltchev, Nedialkov & G. Ivanov, 1999, RMxAA, 35, 13

4. Relationships extinction-dust emission and extinction-gas density in M31
Nedialkov, Berkhuijsen, Nieten & Haas, 2000, immm.proc, 85

5. Toward the extinction in compact HII regions in M31
Nedialkov & Veltchev, 2000, immm.proc, 107

6. Red supergiants in M31: extinction, metallicities and gas-to-dust ratio
Nedialkov & Veltchev, 2002, POBeo, 73, 181

7. Extinction studies in M31
Nedialkov, Valcheva, Veltchev, Stanev, Dyulgerov, Kostov, 2005, ARBl, 20, 113

8. Dust properties of nearby disks: M31 case
Nedialkov, Valcheva, V. Ivanov, Vanzi, 2009, IAU Symposium No. 254, 45

9. Probing the Extinction in M31 via a Spectrum of a Quasar Seen through its Disk
Nedialkov, Williams, Green & Hatzidimitriou, 2011, AIPC, 1356, 45

10. On the mutual location of the nearby galaxies M31, M32 and M110
Georgiev, Nedialkov, Ovcharov & Valcheva, 2015, BlgAJ, 23, 1

11. Study of the extinction law in M31 and selection of red supergiants
Nedialkov & Veltchev, 2015, BlgAJ, 22, 44

OUTSIDE ADS:

12. Red Supergiants and Extinction Law in the Large Magelanic Cloud Galaxy
Nedialkov, Valcheva, Stanev & Dimitrova, 2007, Bulg. J. Phys., 34, 148

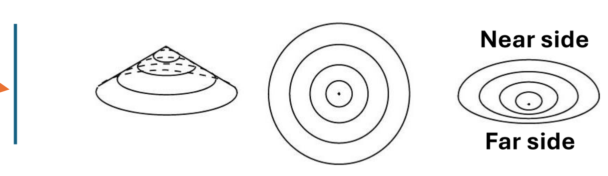
13. Extinction map in the field of M31 as derived from IR photometry of Galactic red dwarfs
Dyulgerov & Nedialkov, 2003, Meetings in Physics, 5, 45

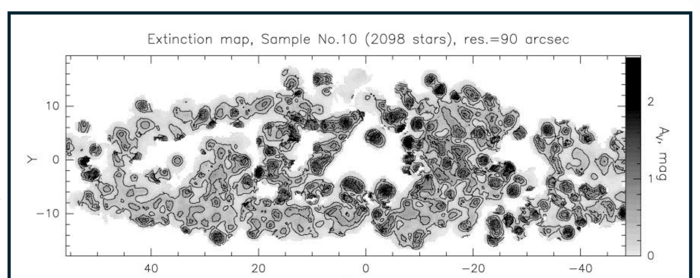
14. X-ray derived Galactic extinction toward M31
Kostov & Nedialkov, 2003, Meetings in Physics, 5, 55

15. Extinction and massive stellar population in Andromeda galaxy
Nedialkov P., 2015, Bulgarian Chemical Communications, 42, 1

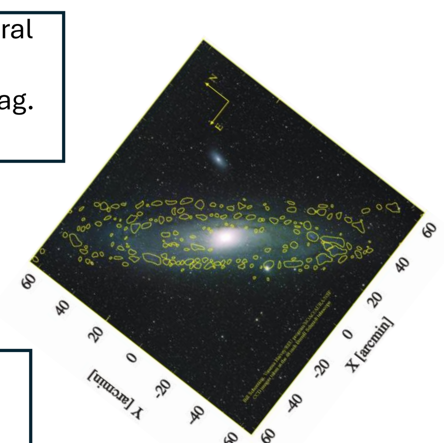
16. Quasars behind the disk of M 31 galaxy
Nedialkov, Williams, V.Ivanov, Valcheva, Solovyeva, Vinokurov, Malygin, Oparin & Sholukhova, 2025, A&A, submitted

From face-on to edge-on orientation the dust in the spiral disks manifests itself by:
- decrease of the integral blue luminosity with 1.1 mag.
- increase of the isophotal diameter D25 with 50%

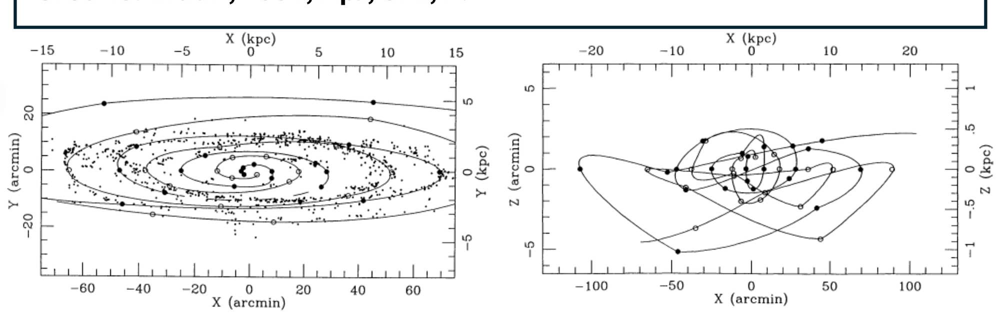


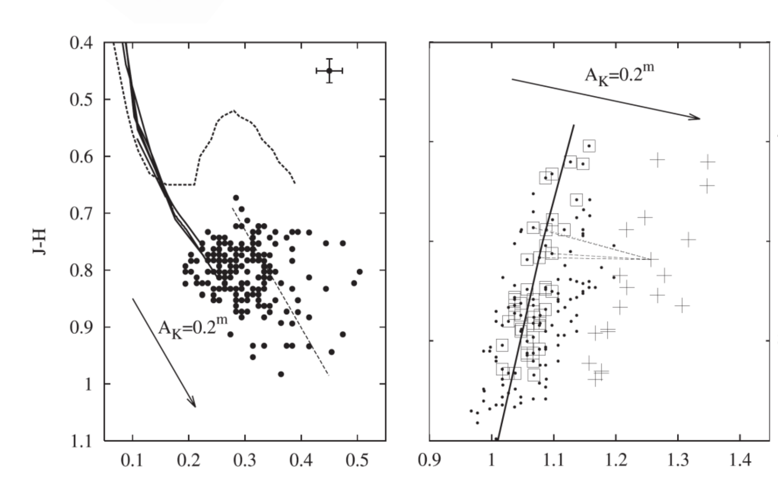


One of the first extinction maps of M31. Based on BVRI photometry (Magnier et al. ,1992, A&ASS, 96, 379) of the brightest OB stars in M31. X and Y are in arcmin.

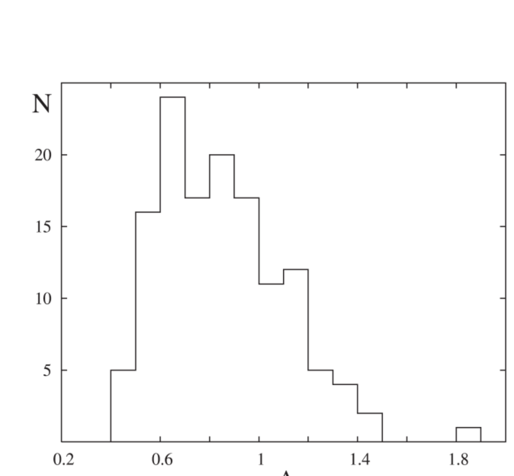


Radial opacity gradient causes the protruding conical surface of the visible disk and the inclination leads to overlapping spiral arms in the eastern far side of the disk rather than departures from the Z=0 plane. Credits: Braun, 1991, ApJ, 372,1 .

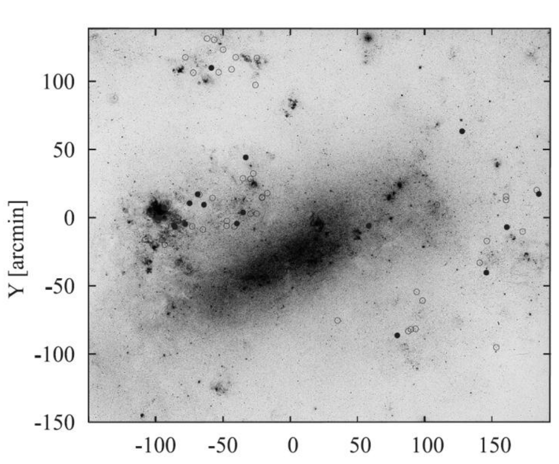




Preliminary selection of moderately reddened (open squares) and extra-reddened (crosses) RSGs on IR color-color (left) and IR color-magnitude (right) diagrams. All stars have optical counterparts. Zero-reddening lines for the Galactic dwarfs (dashed line) and for RSG phase (solid line) are plotted on CC-diagram. The observed RSG branch in LMC is fitted by the bold line on the CM-diagram.



Histogram of the extra-extinction A_V values for all 134 pairs satisfying the selection criteria.

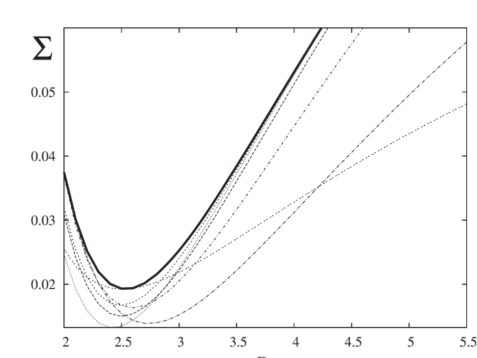


Positions of moderately reddened (open circles) and extra-reddened (filled circles) red supergiants plotted on an optical image of LMC. North is to the top, East is to the left.

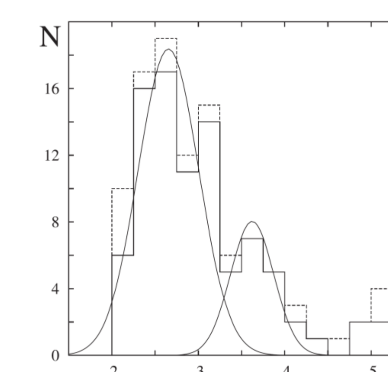
$$\Sigma = \sum_{i=1}^{n}\left[\left(\frac{A_\lambda}{A_V}\right)_{mod} - \left(\frac{A_\lambda}{A_V}\right)_{obs}\right]^2$$

Pair selection criteria:
(i) $A_V > 0$,
(ii) $A_\lambda > 0$, except in *K*&*H*-bands
(iii) $A_K < A_J < A_I < A_R < A_V < A_B$.
134 pairs, satisfying the selection criteria.

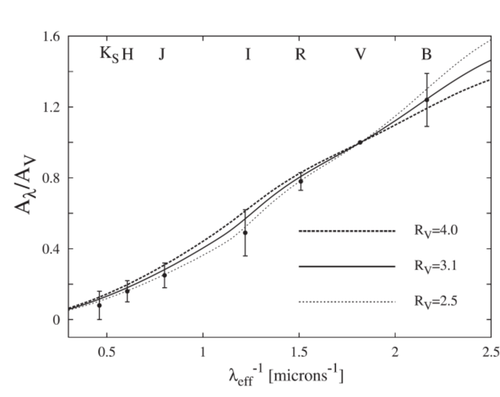
The most typical R_V in LMC equals 2.7 ± 0.4 and differs from the canonical Galactic value with a significance of only 1σ.



Optimization of the R_V value for a pair "moderately – extra-reddened RSG", satisfying the selection criteria. The solid curve refers to the fit of the extinction law at all *BVRIJHK* effective wavelengths and the other curves – at all except one wavelength.



Histograms of the total-to-selective extinction ratio R_V values for 104 pairs with at least 1 successful minimization (dashed line) and 89 pairs with at least 3 successful minimizations (solid line). The decomposed distributions are fitted with gaussians.



Mean values of A_λ/A_V at all *BVRIJHK* effective wavelengths superimposed of the CCM extinction law for three different R_V values.

PETIA YANCHULOVA MERICA-JONES

Born 1978
Sofia, Bulgaria

Citizenship Bulgaria, United States

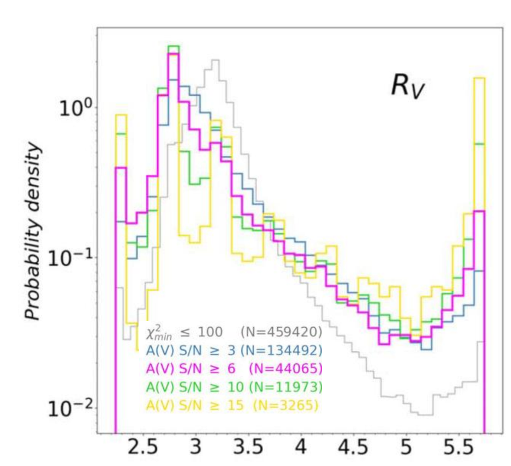
Education
PhD from University of California San Diego (2020)
Thesis The Small Magelanic Cloud: Dust extinction and Three-dimensional Structure from Hubble Space Telescope Observations

Scientific career
Teaching assistant at the Physics Dept. of the University of California, San Diego
Postdoctoral researcher in the ISM*@ST group at the Space Telescope Science Institute
Fulbright U.S. Scholar and a postdoctoral researcher at the Department of Astronomy at Sofia University, Bulgaria
Astronomer at Institute of Astronomy, Bulgarian Academy of Science, Sofia, Bulgaria

Publication list (Astrophysics Data System)
19 publications in total
+10 HST proposals
+5 JWST proposals

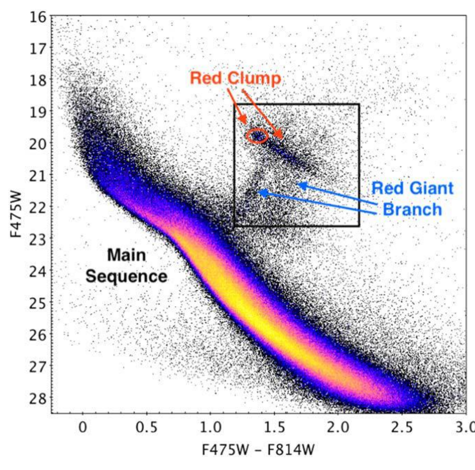

1. 2025arXiv251102947B 2025/11 — Scylla V: Constraints on the spatial and temporal distribution of bursts and the interaction history of the Magellanic Clouds from their resolved stellar populations. Burhenne, Claire; McQuinn, Kristen B. W.; Cohen, Roger E. and 9 more
2. 2025ApJ...989...61C 2025/08 — Nature or Nurture: LMC-like Dust in the Solar Metallicity Galaxy M31. Clayton, Geoffrey C.; Yanchulova Merica-Jones, Petia; Gordon, Karl D. and 6 more
3. 2025ApJ...982...33L 2025/03 — Scylla. IV. Intrinsic Stellar Properties and Line-of-sight Dust Extinction Measurements toward 1.5 Million Stars in the SMC and LMC. Lindberg, Christina W.; Murray, Claire E.; Yanchulova Merica-Jones, Petia and 14 more
4. 2025ApJS..276....8G 2025/01 — The Local Ultraviolet to Infrared Treasury. I. Survey Overview of the Broadband Imaging. Gilbert, Karoline M.; Choi, Yumi; Boyer, Martha L. and 21 more
5. 2025ApJ...978..144Y 2025/01 — A Catalog of Stellar and Dust Properties for 500,000 Stars in the Southwest Bar of the Small Magellanic Cloud. Yanchulova Merica-Jones, Petia; Gordon, Karl; Sandstrom, Karin and 8 more
6. 2024ApJS..275....3M 2024/11 — Scylla. I. A Pure-parallel, Multiwavelength Imaging Survey of the ULLYSES Fields in the LMC and SMC. Murray, Claire E.; Lindberg, Christina W.; Yanchulova Merica-Jones, Petia and 17 more
7. 2024ApJ...975...43C 2024/11 — Scylla. III. The Outside-in Radial Age Gradient in the Small Magellanic Cloud and the Star Formation Histories of the Main Body, Wing, and Outer Regions. Cohen, Roger E.; McQuinn, Kristen B. W.; Murray, Claire E. and 13 more
8. 2024ApJ...975...42C 2024/11 — Scylla. II. The Spatially Resolved Star Formation History of the Large Magellanic Cloud Reveals an Inverted Radial Age Gradient. Cohen, Roger E.; McQuinn, Kristen B. W.; Murray, Claire E. and 11 more
9. 2023ApJS..268...48W 2023/10 — The Panchromatic Hubble Andromeda Treasury. XXI. The Legacy Resolved Stellar Photometry Catalog. Williams, Benjamin F.; Durbin, Meredith; Dalcanton, Julianne; Lang, Dustin and 14 more
10. 2022ApJ...935..105R 2022/08 — METAL: The Metal Evolution, Transport, and Abundance in the Large Magellanic Cloud Hubble Program. IV. Calibration of Dust Depletions versus Abundance Ratios in the Milky Way and Magellanic Clouds and Application to Damped Lyα Systems. Roman-Duval, Julia; Jenkins, Edward B.; Tchernyshyov, Kirill and 9 more
11. 2022ApJ...928...90R 2022/03 — METAL: The Metal Evolution, Transport, and Abundance in the Large Magellanic Cloud Hubble Program. III. Interstellar Depletions, Dust-to-Metal, and Dust-to-Gas Ratios versus Metallicity. Roman-Duval, Julia; Jenkins, Edward B.; Tchernyshyov, Kirill and 9 more
12. 2021ApJ...910...95R 2021/04 — METAL: The Metal Evolution, Transport, and Abundance in the Large Magellanic Cloud Hubble Program. II. Variations of Interstellar Depletions and Dust-to-Gas Ratio within the LMC. Roman-Duval, Julia; Jenkins, Edward B.; Tchernyshyov, Kirill and 9 more
13. 2021ApJ...907...50Y 2021/01 — Three-dimensional Structure and Dust Extinction in the Small Magellanic Cloud. Yanchulova Merica-Jones, Petia; Sandstrom, Karin M.; Johnson, L. Clifton and 6 more
14. 2019ApJ...871..151R 2019/02 — METAL: The Metal Evolution, Transport, and Abundance in the Large Magellanic Cloud Hubble Program. I. Overview and Initial Results. Roman-Duval, Julia; Jenkins, Edward B.; Williams, Benjamin and 18 more
15. 2017ApJ...847..102Y 2017/10 — The Small Magellanic Cloud Investigation of Dust and Gas Evolution (SMIDGE): The Dust Extinction Curve from Red Clump Stars. Yanchulova Merica-Jones, Petia; Sandstrom, Karin M.; Johnson, L. Clifton and 6 more
16. 2014LPI....45.2387C 2014/03 — Role of Symmetry in Mass-Independent Oxygen Isotopic Composition in Laboratory Synthesized Silicates. Chakraborty, S.; Yanchulova, P.; Thiemens, M. H.
17. 2013GeCoA.114..463C 2013/10 — Mass-Independent Oxygen Isotopic Partitioning During Gas-Phase SiO_2 Formation. Chakraborty, Subrata; Yanchulova, Petia; Thiemens, Mark H.
18. 2013LPI....44.1042C 2013/03 — Mass Independent Oxygen Isotopic Composition in Laboratory Synthesized Silicates Via Gas-Phase and Surface Assisted Reactions: Cosmochemical Implications. Chakraborty, S.; Yanchulova, P.; Aguilar, J. and 1 more
19. 2012LPI....43.2300C 2012/03 — Laboratory Observation of Mass-Independent Oxygen Isotopic Composition in Solid Silicates Through Gas Phase Reaction: Cosmochemical Implications. Chakraborty, S.; Yanchulova, P.; Thiemens, M. H.

The study presents a catalog of stellar and dust extinction properties for nearly 500,000 sight lines in the southwest bar of the Small Magellanic Cloud (SMC). Using multiband Hubble Space Telescope data from the SMIDGE survey, the researchers applied the Bayesian Extinction And Stellar Tool (BEAST) to model the spectral energy distributions of individual stars, accounting for observational uncertainties. They found strong correlations between dust extinction (A(V)) and dust mass surface density (Σdust) as well as CO emission (I(CO)), but weaker correlations with neutral hydrogen column density (N(H I)) and polycyclic aromatic hydrocarbons (PAHs; qPAH). The measurements also detected ~200 sight lines with potential evidence of the 2175 Å bump in the extinction curve, which is generally absent in most cases. Additionally, the study revealed distinct dust extinction–distance structures, offering insights into the 3D geometry of the SMC.



The SMIDGE region is located in the southwest bar of the SMC.
The average R(V) value for the High SNR A(V) sample is 3.13. The main peak aligns with the expected SMC dust properties (R(V) = 2.74), while a secondary peak at R(V) ~ 3.2 may be due to either foreground Milky Way dust (R(V) ~ 3.1), Milky Way-style dust within the SMC, or both.
Credits: Yanchulova Merica-Jones et al. , 2025, ApJ, 978, 144

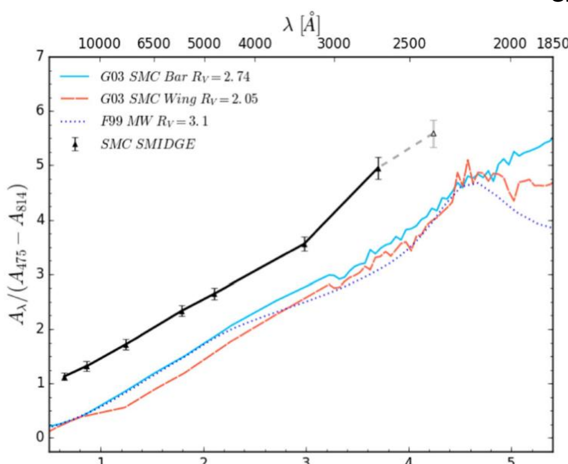
The study investigates the three-dimensional structure and dust extinction in a 200 pc × 100 pc region of the Small Magellanic Cloud's southwest bar using Hubble Space Telescope optical color–magnitude diagrams of red clump and red giant branch stars. The stellar distance distribution is modeled as a Gaussian with a centroid distance of 65.2 kpc (distance modulus μ = 19.07 mag) and a full width at half maximum (FWHM) of approximately 11.3 kpc. The dust layer is found to be offset by 3.22 kpc closer to Earth compared to the stars, resulting in 73% of the stars being reddened. The dust extinction is modeled with a log-normal distribution, showing a mean extinction of ⟨AV⟩ = 0.41 ± 0.09 mag. The calculated dust-to-gas ratio (AV/NH = 3.2–4.2 × 10−23 mag cm^2 H^{-1}) is lower than the Milky Way's value but aligns with previous SMC measurements. This research provides the first combined analysis of dust extinction and 3D geometry in this region, highlighting the effectiveness of CMD modeling for studying nearby galaxies.

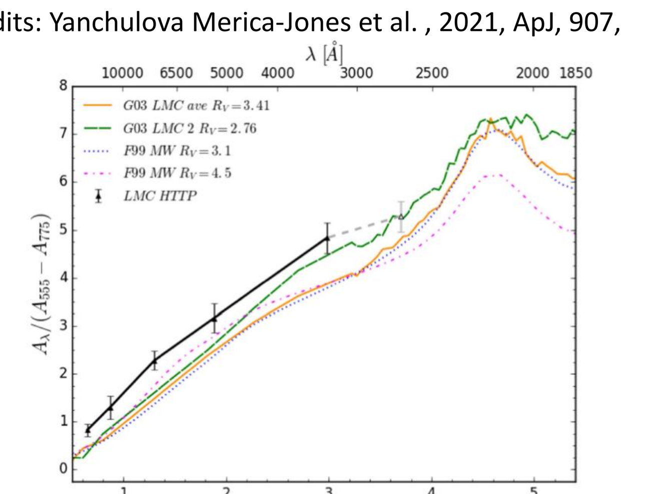


The midpoint of the stellar distribution in the SMIDGE region is located at a distance of 65.2 kpc (distance modulus μ = 19.07 mag). The stellar distribution has a line-of-sight depth with a 1σ spread of 0.16 mag, equivalent to a full width at half maximum (FWHM) of 11.3 kpc. The dust layer is offset 3.22 kpc closer to us than the stars and is located at a distance of 61.94 kpc (distance modulus μ = 18.96 mag). 73% of the stars are reddened due to the dust layer. The dust extinction has a mean value of ⟨AV⟩ = 0.41 ± 0.09 mag, with a width of σ(AV) = 0.097 ± 0.003 mag.

Credits: Yanchulova Merica-Jones et al. , 2021, ApJ, 907,

The study used Hubble Space Telescope (HST) observations of red clump stars from the Small Magellanic Cloud Investigation of Dust and Gas Evolution (SMIDGE) program to measure the average dust extinction curve in a 200 pc × 100 pc region of the southwest bar of the Small Magellanic Cloud (SMC). Using eight-band ultraviolet to near-infrared photometry, researchers modeled the color–magnitude diagram of the red clump, considering the extinction curve shape, a log-normal distribution of AV (extinction), and the depth of the stellar distribution along the line of sight. They measured an extinction curve with R475 = 2.65 ± 0.11, which is higher than previously published values for the Milky Way (R475 = 1.83) and the SMC Bar (R475 = 1.86). While similar offsets in the Large Magellanic Cloud (LMC) have been linked to large dust grains, the study found that the apparent "gray" contribution to the extinction curve is due to the line-of-sight depth of the SMC (10 ± 2 kpc) and LMC (5 ± 1 kpc). This eliminates the need to assume a gray dust component and highlights the effectiveness of HST imaging in studying dust and galactic structure beyond the Milky Way.





Left: SMC SMIDGE extinction curve, plotted in black. Right: 30 Dor LMC extinction curve.
For comparison other extinction curves are plotted.
Credits: Yanchulova Merica-Jones et al. 2017, ApJ, 847,102

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