QED induced Redshift and Anomalous Microwave Emission from Dust

Thomas V. Prevenslik

QED Radiations, Discovery Bay, Hong Kong, China; thomas@nanoqed.org

Received July 21, 2015; accepted November 30, 2015

Abstract: Cosmology considers the Hubble redshift of galaxy light by the Doppler's effect as proof of CMB and Universe expansion since the Big Bang. However, cosmic dust that permeates the Universe also redshifts galaxy light that if not corrected over-predicts the velocities of Universe expansion. Similarly, the Planck satellite imaging AME polarizations over frequencies from radio (30 GHz) to submillimetre (857 GHz) allowing extrapolation of 353 GHz Planck data to 160 GHz suggested the AME was caused by dust and was not a relic of gravitational waves formed at the Big Bang. AME stands for Anomalous Microwave Emission. QED induced EM radiation in dust NPs is proposed to be the basis by which Universe expansion may be assessed. QED stands for quantum electrodynamics, EM for electromagnetic, and NPs for nanoparticles. QED radiation is a consequence of QM that denies the atoms in NPs under TIR confinement the heat capacity to allow increases in NP temperature upon absorbing galaxy light. QM stands for quantum mechanics and TIR for total internal reflection.

Key words: cosmology, cosmic dust, redshift, anomalous microwave emission, quantum mechanics, QED

1. INTRODUCTION

Man has always pondered the origin of the Universe. Humans know life has a beginning and an end, and it is only natural to think the Universe also has a beginning and an end. Yet, for thousands of years, the Universe was considered static and infinite - without a beginning and end. However, Einstein in 1916 introduced his field equations that required the Universe to be finite and either contracting or expanding. Since a static Universe is foreign to human experience, Einstein provided a theoretical basis to suggest the Universe is indeed not static. But lacking experimental proof, Einstein's theory lay dormant until 1929 when Hubble dismissed a static Universe by showing the light from distant galaxies was redshift. Interpreted by the Doppler effect, the Hubble redshift was taken as proof the Universe is finite and expanding consistent with human experience now supported by Einstein's field equations that continues to this day.

However, cosmic dust that permeates the ISM also redshifts galaxy light that if not corrected over-predicts the velocities of Universe expansion. ISM stands for interstellar medium. QED is proposed as the theory by which the EM energy of a galaxy photon is redshift upon absorption in a cosmic dust NP under TIR confinement. QED induced redshift is a consequence of QM that forbids the atoms in NPs under TIR to have the heat capacity to increase in temperature upon absorbing the EM energy of the galaxy photon. The TIR confinement of the galaxy photon in cosmic dust NPs is not permanent and only occurs during absorption, i.e., absent TIR there is no QED induced redshift. Upon absorption, the EM energy of the galaxy photon is redshift by QED depending on the geometry of the NP. Redshift only occurs as the NP absorbs a single galaxy photon, i.e., blueshift requiring EM energy greater than that of the galaxy photon cannot occur as the conservation of energy would be violated. The QM restriction on the heat capacity may be understood from the Einstein & Hopf (1910) relation for the atom as a harmonic oscillator at 2.7 and 300 K shown in Figure 1.

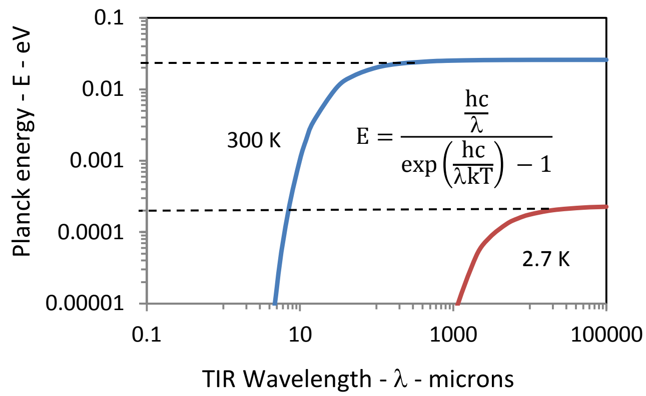

Figure 1. Planck energy of the atom as a Harmonic oscillator
In the inset, E is Planck energy, h Planck's constant, k Boltzmann's constant,
λ the TIR wavelength, T absolute temperature, and c the velocity of light.

Unlike classical physics allowing the atom to always have heat capacity from the macro to the nanoscale, QM requires the heat capacity to vanish at the nanoscale precluding increases in temperature upon the absorption of galaxy light in dust NPs. Fig. 1 shows the macroscale by classical physics (noted by dotted lines) at 300 and 2.7 K corresponds to λ > 30 and 3000 microns, respectively. At the nanoscale, the QM heat capacity vanishes, i.e., for λ < 1 and 1000 microns is reduced more than 2000 and 20 times from classical theory.

Recently, the Planck satellite imaged AME polarizations from radio to submillimetre frequencies. Extrapolation of 353 GHz Planck data to 160 GHz suggests the AME is caused by dust and not the CMB as a relic of gravity waves from Universe expansion. CMB stands for cosmic microwave background. In this regard, QED induced EM radiation in dust NPs is proposed as the commonality by which an expanding Universe may be assessed. Like QED induced redshift in dust, AME induced from dust NPs is a consequence of QM that denies the atoms in NPs under TIR confinement the heat capacity to increase NP temperature upon absorbing galaxy light.

2. PURPOSE

By the theory of QED induced EM radiation, to show galaxy light is redshift and produces AME upon absorption in spherical NPs of cosmic dust. Although applicable to the absorption all galaxy light, only single Lyα photons are primarily discussed because of their relative abundance yet having Planck energy in the extreme UV provides maximum redshift and AME. For comparison, the lower energy Hα photons are also discussed. Lyα and Hα stands for the Lyman α and Hydrogen α photon.

3. THEORY AND ANALYSIS

Lack of heat capacity by QM precludes EM energy conservation in NPs by an increase in temperature, and instead, conservation proceeds by QED inducing the EM energy of the single Lyα or Hα photons to be confined to the TIR frequency of the NP.

Why is TIR important?

In 1870, Tyndall showed light is confined by TIR to the surface of a body if its refractive index RI is greater than that of the surroundings. Extended to the interaction of galaxy light within dust NPs, galaxy light upon absorption is placed under TIR confinement by the higher RI of the NP compared to the void of the ISM. For discussion, galaxy light is limited to discrete Lyα or Hα photons. Since NPs have high surface to volume ratios, an absorbed galaxy photon is induced by QED to be totally confined by TIR to the NP surface. Hence, the TIR wavelength λ of the QED photon moving at speed c/n in the NP surface is, λ = 2πan, the TIR frequency $\upsilon = (c/n)/\lambda = c/2\pi an$, where c is the speed of light, and n and a are the RI and radius of the NP.

Simply put, QED induces the galaxy photon wavelength λ^* to equal the QED wavelength λ = 2πan, where λ^* for Lyα or Hα photons is 0.1217 and 0.656 microns, respectively. If $\lambda > \lambda^*$, the NP redshifts the galaxy photon, but if $\lambda < \lambda^*$, a blueshift photon is suggested but is forbidden as the conservation of energy would be violated. But if $\lambda < \lambda^*$,

How does conservation proceed?

Obviously, NP spinning is desirable as then the rotating dipoles within the NP would produce the AME. Indeed, it has been shown by Friese, et al. (1996) that micron-sized CuO particles rotate under circularly polarized light. Galaxy light emission from the stars is not polarized, but Nature produces circular polarization of galaxy light during absorption in the TIR mode of NPs. Circular polarization is depicted over the time during absorption of a galaxy photon in Fig. 2. Once absorbed, a momentary torque is exerted on the NP that causes spinning.

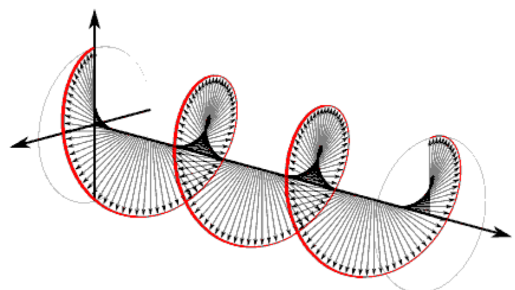

Figure 2. Circular Polarization of galaxy light upon absorption in the TIR mode of a NP.

Whether QED induces the NP to redshift galaxy light or the NP to spin depends on the wavelengths of the galaxy and QED photons, i.e., for $\lambda^* = \lambda$, $a = \lambda^*/2\pi n$. For Lyα and Hα galaxy photons absorbed in amorphous silica NPs having n = 1.5, a = 0.0125 and 0.070 microns, respectively. NPs having a < 0.0125 microns spin upon absorbing Lyα photons, while all others redshift the Lyα photon to produce VIS and near IR light. Similarly, the Hα photon produces spin in NPs having a < 0.07 microns, but otherwise redshifts the Hα photon. In the ISM, the range of NP radii given by Weingartner & Draine (2001) is 0.001 < a < 0.25 microns.

3.1 Redshift

The QED redshift galaxy photon induced in dust NPs is observed on Earth at wavelength λ giving the redshift Z,

$$Z = \frac{\lambda - \lambda^*}{\lambda^*} \tag{1}$$

Or,

$$\lambda = (1 + Z)\lambda^*$$

The QED induced redshift is caused solely by the absorption of the galaxy photon in cosmic dust. Relative to the velocity of light c, the Doppler velocity V of galaxies with redshift Z is,

$$\frac{V}{c} = \frac{(Z+1)^2 - 1}{(Z+1)^2 + 1} \tag{2}$$

For amorphous silica, the QED redshift of Lyα and Hα lines in dust and the galaxy velocity ratio V/c based on the Lyα line is shown in Fig. 3. The galaxy velocity ratio V/c inferred by the Doppler redshift by dust may be a significant fraction of the velocity of light c making any astronomical measurement questionable as the galaxy need not be receding at all. What this means is dust affects the accuracy of any astronomical velocities inferred from Hubble redshift.

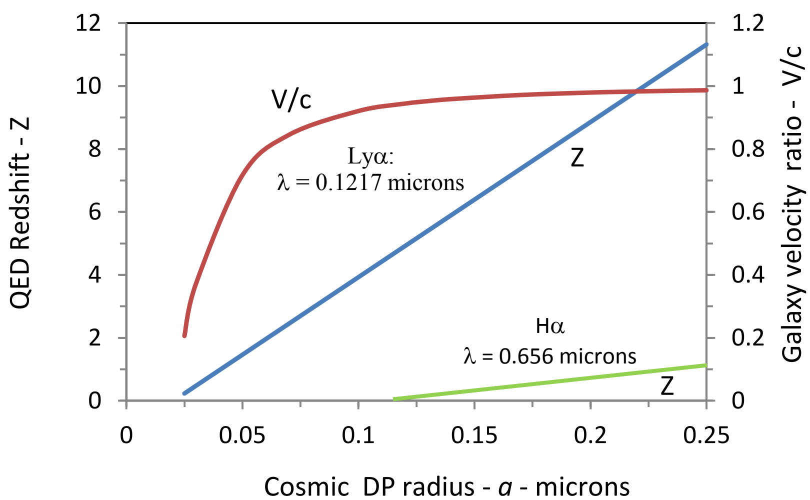

Figure 3 QED Induced Redshift of Lyα and Hα lines
Amorphous Silicate: n = 1.5

The Hubble redshift by the Doppler Effect gives the same Z for ALL wavelengths, but QED redshift in dust depends on wavelength. Historical data by Minkowski & Wilson (1956) supports the Hubble redshift at low Z < 0.05, but excludes the Lyα line that gives the largest QED redshift in cosmic dust. Therefore, to assess Hubble redshift validity, measured Z is corrected with the difference in redshifts of Lyα and Hα lines,

$$Z_{Hubble} = Z_{Meas} - (Z_{Ly\alpha} - Z_{H\alpha}) \tag{3}$$

If redshift measurements of QED redshift of Lyα and Hα lines show,

$$Z_{Ly\alpha} = Z_{H\alpha}$$

Then

$$Z_{Hubble} = Z_{Meas}$$

and the effect of cosmic dust on Hubble redshift by the Doppler effect may be neglected. If not, the validity of the Hubble redshift is questionable.

3.2 AME

Since the TIR mode is tangential to the surface of the NP, QED induces the Lyα or Hα photons to produce circularly polarized light upon absorption thereby exerting a momentary torque on the NP. Conserving the Lyα or Hα photon energy hc/λ* with the rotational energy ½ Jω^2 of the NP gives the AME emission frequency υ from the NP spin ω,

$$\upsilon = \frac{\omega}{2\pi} = \frac{1}{2\pi}\sqrt{2\frac{hc}{J\lambda^*}} \qquad (4)$$

where, h is Planck's constant. The NP: rotational moment of inertia J = 2 ma^2/5, mass m = 4πρa^3/3, and density ρ. Hence, the NP spin ω caused by the absorption of Lyα photons in amorphous silica NPs having boundaries a_{min} < a < 0.0125 microns, while for Hα photons the boundaries are a_{min} < a < 0.070 microns. Here, a_{min} = 0.0003 microns.

3.3 Summary

Contrary to classical physics, QM forbids a temperature spike to initiate AME in dust NPs. QED induced redshift and AME in dust NPs is given in terms of boundaries of NP size depending on and the Planck energy of absorbed galaxy light shown for the Lyα and Hα photon in Fig. 4.

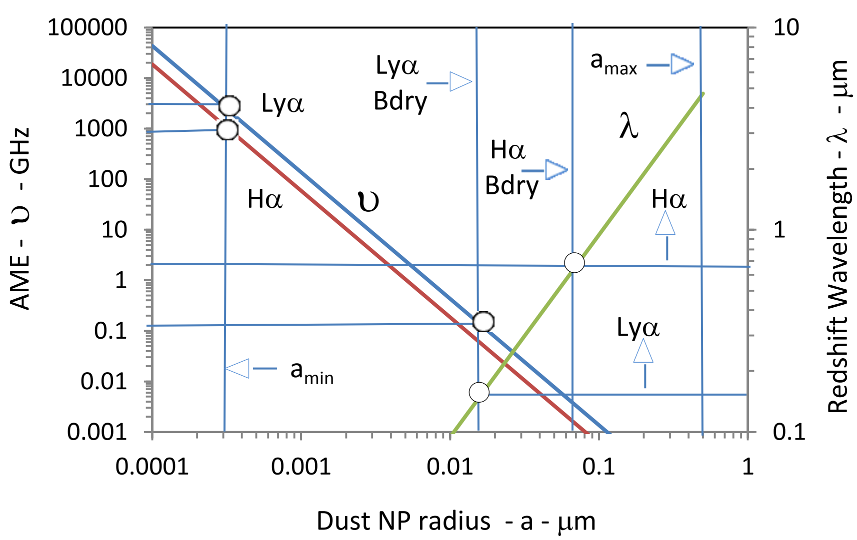

Figure 4. AME and Redshift in Dust from absorbed Lyα and Hα Photons

The Lyα boundary is shown to occur at a = 0.0125 microns and λ = λ* = 0.1217 microns. NPs having radii a < 0.0125 microns produce AME from 100 MHz. The upper AME limit of 3000 GHz occurs at the minimum NP radius a_{min} = 0.0003 microns; whereas, for NP radii a > 0.0125 microns the Lyα photon is redshift to λ > λ*. Similarly, the Hα boundary occurs at a = 0.07 microns and λ = λ* = 0.656 microns with AME produced from 2 to 900 GHZ while the Hα photon is redshift to λ > 0.656 microns.

QED redshift is upper bound depending on the largest NP size. Here, the maximum NP radius a_{max} = 0.5 microns. Hence, Lyα and Hα photon redshift is limited to the near IR at about 5 microns. UIR bands require NPs having a_{max} > 0.5 microns.

4. DISCUSSION

4.1 Redshift Emission

Dust is thought to emit EM radiation by thermal emission at near to far IR wavelengths from non-equilibrium heating by single galaxy photons. Indeed, single-photon heating can raise the temperature of very small NPs (a < 0.0025 microns) to 40 K so that much of the absorbed energy will be radiated in the far IR near 60 microns, e.g., see Li & Draine (2001) and Purcell (1976).

However, the notion that NPs heat-up upon absorption of a single galaxy photon is based on classical physics that allows the atom to always have heat capacity. Contrarily, QM precludes NP atoms under TIR confinement to have the heat capacity to conserve the absorbed galaxy photon by a spike in temperature. For Lyα or Hα photons, Fig. 4 shows QED radiation based on QM produces the IR bands by redshift of absorbed galaxy photons without increasing the NP temperature.

4.2 AME Emission

Non-thermal AME based on the collisions of dust NPs with gases was proposed by Erickson (1957). Based on classical physics, the NP rotational velocity increases in subsequent random collisions, but many collisions are required for the AME to reach GHz levels, i.e., large NPs require hundreds of thousands of years while only a few years are required for small NPs. Moreover, high brightness temperatures inferred at AME frequencies suggest high NP temperatures exist. QM differs as the NPs are denied the heat capacity to increases in temperature upon the absorption of any EM energy including collisions.

Generally, non-thermal AME is thought caused by the increase in temperature of NPs upon absorption of single galaxy photons, the temperature inducing conversion of vibration to NP rotation and subsequent AME by dipole spin. But again, QM precludes any temperature increases thereby precluding any conversion to NP rotation. However, astronomy following classical physics differs and allows the absorption of galaxy photons to cause NP rotation, e.g., Ali-Haimoud (2012) states:

> "Luckily Nature does provide us with such an efficient process to change ω at constant L: internal vibrational-rotational energy transfer (IVRET)…Purcell (1979), Sironi & Draine (2009), Hoang, Lazarian, and Draine(2011)...Following the absorption of an ultraviolet (UV) photon, small grains get heated up to large vibrational temperatures T_{vib} (the notion of temperature is not well defined for the smallest grains, so we mean temperature as a characteristic energy per degree of freedom). IVRET leads to a rapid energy exchange between vibrational and rotational degrees of freedom, at constant angular momentum, so that during a thermal spike, the distribution given by T_{vib}. As the grain cools down by emitting infrared photons, its vibrational temperature decreases, until the grain reaches its fundamental vibrational mode, with typical energy E =kT at 100 K."

Contrarily, Nature does not provide an efficient process to convert vibration to rotation. The origin of the Hubble redshift and the AME cannot be discovered by classical physics as QM governs the nanoscale and precludes temperature changes in NPs and PAH molecules as the source for AME. Fig. 1 shows the notion of temperature as a characteristic degree of freedom is meaningless as the kT energy of the atom vanishes at the nanoscale by QM. Energy exchange between vibrational and rotational degrees of freedom and cooling down NPs to 100 K cannot occur as temperature has no meaning at the nanoscale. Indeed, the notion that heating a NP induces rotational motion is highly questionable as it is well known in the everyday world that heating a body does not cause it to rotate. In contrast, QM differs as heat absorbed in the TIR mode of a NP directly produces circular polarization that spontaneously induces spinning and does not require years to reach GHz frequencies.

The AME power radiated $dP/d\upsilon$ given by Ali-Haimoud (2012),

$$\frac{dP}{d\upsilon} = \frac{2\mu^2}{3c^3}(2\pi\upsilon)^4 \tag{5}$$

where, μ is the dipole moment of the number N_{atom} of atoms within the NP, $\mu^2 = N_{atom}\,\beta^2$. Here, $\beta \cong$ 0.4, 1, 3, 6.4 Debye, where 1 Debye = 1D = $3.33\text{x}10^{-30}$ C-m.

In the simulation, the density of spherical NPs was 2650 kg/cm^3 and the number N_{atom} of atoms was based on a cubical atomic volume of $(0.25\ nm)^3$. Dipole moments of μ = 0.4 to 6.4 D are representative of an extensive list of molecules in the ISM by Muller & Woon (2013). The CMB foreground was assumed confined to a 1 AU thin dust zone with dust number density of $1\text{x}10^{-6}\ m^{-3}$ Schlegel al. (1998). Fig. 5 shows the magnitude of the QED induced frequency υ dependent AME for various dipole moments superposed on the CMB at a reduced 0.0001 amplitude.

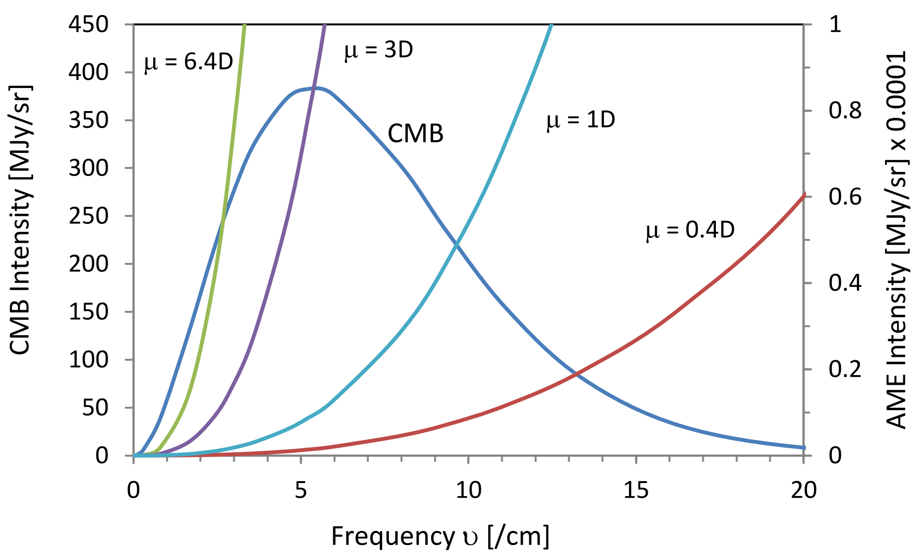

Figure 5. CMB v. QED induced AME for various Dipole Moments

Fig. 5 shows the AME is a small fraction of the CMB intensity. At the CMB peak frequency 5.2 cm^{-1}, the CMB intensity is 370 MJy/sr while the AME for the μ = 3D dipole moment is $8.5\text{x}10^{-5}$ MJy/sr. Hence, the largest fractional error in the CMB by AME is $2.3\text{x}10^{-7}$ with smaller errors for the other dipole moments.

5. CONCLUSIONS

Universe expansion may be assessed by the effects of cosmic dust in measurements of both Hubble's redshift and the AME error in the CMB.

Hubble redshift requires measured redshift corrected for QED induced redshift in cosmic dust based on independent measurements of Lyα and Hα lines,

$$Z_{Hubble} = Z_{Meas} - (Z_{Ly\alpha} - Z_{H\alpha})$$

The CMB distortion caused by QED induced AME in cosmic dust appears to be insignificant. The CMB error is found to be < 8.5×10^{-5} MJy/sr at 5.2 cm^{-1}. However, the NP number density and the size of the foreground require further study.

References

Corasaniti, P.S., The Impact of Cosmic Dust on Supernova Cosmology, MNRS, February 2008

Draine, B. T. & Li, A. 2001, Infrared emission from interstellar dust. I. Stochastic heating of small grains, Astrophys. J., 551, 807.

Einstein A. & Hopf, L. 1910, Statistische Untersuchung der Bewegung eines Resonators in einem strahlungsfeld, Ann. Physik, 33, 1105.

Erickson, W. C. 1957, A Mechanism of Non-Thermal Radio-Noise Origin, Astrophys. J., 126, 480.

Friese, M. E. J., Enger, J., Rubinsztein-Dunlop, H., Heckenberg, N. R. 1996, Optical angular-momentum transfer to trapped absorbing particles, Phys. Rev. A, 54, 1593.

Hoang, T., Lazarian, A. & Draine, B. T. 2011, Spinning Dust Emission: Effects of Irregular Grain Shape, Transient Heating, and Comparison with Wilkinson Microwave Anisotropy Probe Results. Astrophys. J., 741, 87.

Li, A. 2005, Interstellar Grains – The 75th Anniversary, Institute of Physics Publishing Journal of Physics: Conference Series 6 , 229–248.

Li, A. & Draine, B. T. 2001, infrared emission from interstellar dust. II. The diffuse interstellar medium, Astrophys. J., 554, 778.

Minkowski, R. & Wilson, O. S. 1956, Proportionality of Nebular Red Shifts to Wave length, Astrophys. J, 123, 373

Mueller, H. S. P. & Woon, D. E. 2013, Calculated Dipole Moments for Silicon and Phosphorus Compounds of Astrophysical Interest, J. Phys. Chem. A , 117, 13868.

Prevenslik, T. V. 2014, Cosmology by Cosmic Dust, See APRIM at http://www.nanoqed.org

Purcell, E. M. 1976, Temperature fluctuations in very small interstellar grains. Astrophys. J. 206, 685.

Purcell, E. M. 1979, Suprathermal rotation of interstellar grains, Astrophys. J., 231:404.

Schlegel, D. J., Finkbeiner, D.P. & Davis, M. 1998, Maps of dust infrared emission for use in estimation of reddening and Cosmic microwave background radiation foregrounds, Astrophys. J., 500, 525.

Sironi, L. & Draine, B. T. 2009, Polarized Infrared Emission by Polycyclic Aromatic Hydrocarbons Resulting from Anisotropic Illumination, Astrophys. J., 698, 1292.

Weingartner, J.C. & Draine, B. T. 2001, Dust Grain Size Distributions and Extinction in the Milky Way, Large Magellanic Cloud, and Small Magellanic Cloud, Astrophys. J., 548, 296.