This international standard was developed in accordance with internationally recognized principles on standardization established in the Decision on Principles for the Development of International Standards, Guides and Recommendations issued by the World Trade Organization Technical Barriers to Trade (TBT) Committee.

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Standard Terminology Relating to Space Simulation[1]

This standard is issued under the fixed designation E349; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ε) indicates an editorial change since the last revision or reapproval.

ε^1 NOTE—Editorial changes were made to the definition of "thermal radiator" in November 2019.

INTRODUCTION

These definitions pertain to technologies related to space environment simulation. Where possible, existing international and national standard definitions have been used.

ELECTROMAGNETIC RADIATION TERMS

FUNDAMENTAL CONCEPTS

absorption, *n*—transformation of radiant energy to a different form of energy by interaction with matter.

complex radiation, *n*—radiation composed of a number of monochromatic radiations.

diffusion, *n*—change of the spatial distribution of a beam of radiation when it is deviated in many directions by a surface or a medium.

emission, *n*—release of radiant energy.

infrared radiation, *n*—radiation for which the wavelengths of the monochromatic components are greater than those for vissible radiation, and less than about 1 mm.

NOTE 1—The limits of the spectral range of infrared radiation are not well defined and may vary according to the user. Committee E-2.1.2 of the CIE distinguishes in the spectral range between 780 nm and 1 mm:

IR-A	780 to 1400 nm
IR-B	1.4 to 3 µm
IR-C	3 µm to 1 mm

irradiation, *n*—application of radiation to an object.

monochromatic radiation, *n*—radiation characterized by a single frequency. By extension, radiation of a very small range of frequency or wavelength that can be described by stating a single frequency or wavelength.

radiation, *n*—(*1*) emission or transfer of energy in the form of electromagnetic waves or particles.
(*2*) the electromagnetic waves or particles.

NOTE 2—In general, nuclear radiations and radio waves are not considered in this vocabulary, only optical radiations, that is, electromagnetic radiations (photons) of wavelengths lying between the region of transition to X-rays (1 nm) and the region of transition to radio waves (1 mm).

reflection, *n*—return of radiation by a surface without change of frequency of the monochromatic components of which the radiation is composed.

refraction, *n*—change in the direction of propagation of radiation determined by change in the velocity of propagation in passing from one medium to another.

spectrum of radiation, *n*—(*1*) spatial display of a complex radiation produced by separation of its monochromatic components.
(*2*) composition of a complex radiation.

transmission, *n*—passage of radiation through a medium without change of frequency of the monochromatic components of which the radiation is composed.

ultraviolet radiation, *n*—radiation for which the wavelengths of the monochromatic components are smaller than those for visible radiation and more than about 1 nm.

NOTE 3—The limits of the spectral range of ultraviolet radiation are not well defined and may vary according to the user. Committee E-2.1.2 of the CIE distinguishes in the spectral range between 100 and 400 nm:

UV-A	315 to 400 nm
UV-B	280 to 315 nm
UV-C	100 to 280 nm

visible radiation, *n*—any radiation capable of causing a visual sensation.

NOTE 4—The limits of the spectral range of visible radiation are not well defined and may vary according to the user. The lower limit is generally taken between 380 and 400 nm and the upper limit between 760 and 790 nm (1 nanometer, nm = 10^{-9} m).

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[1] These definitions are under the jurisdiction of ASTM Committee E21 on Space Simulation and Applications of Space Technology and are the direct responsibility of Subcommittee E21.04 on Space Simulation Test Methods.

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QUANTITIES

absorptance, *n*—ratio of the absorbed radiant or luminous flux to the incident flux. Symbol: α_e, α_v, α.

NOTE 5—In general, the value of the absorptance depends upon the mode of irradiation, the spectral composition, and the state of polarization of the incident radiation.

absorptivity of an absorbing material, *n*—internal absorptance of a layer of the material such that the path of the radiation is of unit length.

diffuse reflection, *n*—diffusion by reflection in which, on the macroscopic scale, there is no regular reflection.

diffuse transmission, *n*—transmission in which diffusion occurs independently, on the macroscopic scale, of the laws of refraction.

directional emissivity of a thermal radiator, *n*—ratio of the thermal radiance of the radiator in a given direction to that of a full radiator at the same temperature. Symbol: ε(θ, φ); $\varepsilon(\theta, \varphi) = L_{e,th}(\theta,\varphi)/L_{e\,(\varepsilon = 1)}$.

emissivity of a thermal radiator, *n*—ratio of the thermal radiant exitance of the radiator to that of a full radiator at the same temperature. Symbol: ε, $\varepsilon = M_{e,th}/Me(\varepsilon = 1)$.

NOTE 6—Formerly "*pouvoir émissif*" (fr.).

frequency, *n*—reciprocal of the period. Symbol; *f*, ν.

NOTE 7—When the independent variable is time, the unit of frequency is the hertz. Symbol: Hz (1 Hz = 1 s^{-1}). (This unit is also called "cycle per second," c/s.)

full radiator: blackbody (USA), Planckian radiator, *n*—thermal radiator that absorbs completely all incident radiation, whatever the wavelength, the direction of incidence, or the polarization. This radiator has, for any wavelength, the maximum spectral concentration of radiant exitance at a given temperature.

goniophotometer, *n*—photometer for measuring the directional light distribution characteristics of sources, lighting fittings, media, and surfaces.

NOTE 8—A goniophotometer for measuring the spatial distribution of luminous intensity is also called a distribution photometer.

gray body, *n*—nonselective radiator whose spectral emissivity is less than one.

integrating (Ulbrecht) sphere, *n*—part of an integrating photometer. A sphere that is coated internally with a white diffusing paint as nonselective as possible and is provided with an associated equipment for making a photometric measurement at a point of the inner surface of the sphere. A screen placed inside the sphere prevents the point under observation from receiving any radiation directly from the source.

internal absorptance of a homogeneous nondiffusing plate, *n*—ratio of the radiant or luminous flux absorbed between the entry and exit surfaces of the plate to the flux which leaves the entry surface. Symbol: a_i , $a_i + \tau_i = 1$.

NOTE 9—For a given plate, the internal absorptance is a function of the path length of the radiation in the plate and thus of the angle of incidence. The fundamental concept is spectral internal absorptance. $a_i(\lambda)$.

internal transmission density, *n*—logarithm to the base 10 of the reciprocal of the internal transmittance. Symbol: D_i, $D_i = -\log_{10} \tau_i$.

NOTE 10—See Note 12 of **internal transmittance**.

NOTE 11—In German, the symbol *E* is still in use and the natural logarithm is also used sometimes instead of the common logarithm; the corresponding quantity is then called "natürliches Absorptionsmass." (= In 1/τi).

internal transmittance of a homogeneous nondiffusing plate, *n*—ratio of the radiant or luminous flux reaching the exit surface of the plate to the flux which leaves the entry surface.

NOTE 12—For a given plate, the internal transmittance is a function of the path length of the radiation in the plate and thus of the angle of incidence. The fundamental concept is "spectral internal transmittance" τ(λ).

irradiance at a point on a surface, *n*—quotient of the radiant flux incident on an element of the surface containing the point by the area of that element. Symbol: E_e, *E*; $E_e = d\Phi_e/dA$; Unit: Watt per square metre, $W{\cdot}m^{-2}$.

NOTE 13—In ultraviolet radiation therapy and photobiology, this quantity is called dose rate (International Photobiology Committee, 1954).

linear absorption coefficient of an absorbing medium, *n*—quotient of the internal absorptance of a path element traversed by the radiation, by the length *d* of this element. Symbol: *a*; $-d\Phi = a\Phi dl$; Unit: m^{-1}; $al = \ln 10D_i$.

NOTE 14—The linear absorption coefficient is also the part of the linear attenuation coefficient that is due to absorption.

NOTE 15—In German practice, a linear absorption coefficient is also defined for a homogeneous medium of finite thickness *d*, as the quotient of the "Absorptions-mass" (logarithm of the reciprocal of the internal transmittance), by the thickness *d* of the layer. According to whether the natural logarithm or the logarithm to the base 10 is used, one may distinguish the "natürliche Absorptionskoeffizient" (m_n) quotient of the "natürliche Absorptionsmass" (see Note 2, **internal transmission density**) by the thickness *d* of the layer traversed by the radiation, and the "dekadische Absorptionskoeffizient" (*m*) quotient of the internal transmission density by the thickness *d* of the layer.

NOTE 16—*a*/ρ, where ρ is the density of the medium, is called "mass absorption coefficient."

linear attenuation (extinction) coefficient of an absorbing and diffusing medium, for a collimated beam of radiation**,** *n*—quotient of the relative decrease in spectral concentration of radiant or luminous flux of a collimated beam of radiation during traversal with normal incidence of an infinitesimal layer of the medium by the thickness of that layer. Symbol: μ; $-d\Phi = \mu\Phi dl$; Unit: m^{-1}.

NOTE 17—This concept only applies strictly to slightly diffusing media.

NOTE 18—μ/ρ, where ρ is the density of the medium, is called the "mass attenuation coefficient."

mixed reflection, *n*—partly regular and partly diffuse reflection.

NOTE 19—The irradiance or illuminance received from a point source after regular (diffuse) reflection varies inversely as the square of the distance to the source (diffuser).

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mixed transmission, *n*—partly regular and partly diffuse transmission.

NOTE 20—The irradiance or illuminance received from a point source, after regular (diffuse) transmission, varies inversely as the square of the distance to the source (diffuser).

nonselective radiator, *n*—thermal radiator whose spectral emissivity is independent of wavelength over the range considered.

opaque body, *n*—body that transmits practically no light.

period, *n*—size of the minimum interval of the independent variable after which the same characteristics of a periodic phenomenon recur.

NOTE 21—In radiation, the independent variable is the time and the corresponding quantity is the periodic time: Symbol: T; Unit: second (s).

photometer, *n*—instrument used for measuring photometric quantities.

photometry, *n*—measurement of quantities referring to radiation, evaluated according to the visual effect which it produces, as based on certain conventions.

radiance (in a given direction, at a point on the surface of a source or receptor or at a point in the path of a beam)**,** *n*—quotient of the radiant flux leaving, arriving at, or passing through an element of surface at this point and propagated in directions defined by an elementary cone containing the given direction by the product of the solid angle of the cone and the area of the orthogonal projection of the element of surface on a plane perpendicular to the given direction. Symbol: L_e, L; $L_e = d^2\Phi$ ($d\omega\ dA \cos \Theta$); Unit: Watt per steradian and per square metre, $W \cdot sr^{-1}\ m^{-2}$.

NOTE 22—Three special cases may be noted:

Case 1—At a point on the surface of a source, in a given direction, radiance is also the quotient of the radiant intensity in the given direction of an element of the surface at this point, by the area of the orthogonal projection of this element on a plane perpendicular to this direction (radiant intensity per unit projected area). $L_e = dI_e/(dA \cos \Theta)$.

Case 2—At a point on the surface of a receptor, in a given direction, radiance is also the quotient of the irradiance that is received at this point on a surface perpendicular to the given direction by the solid angle of the elementary cone containing this direction and surrounding the beam which produces this irradiance (perpendicular irradiance per unit solid angle). $L_e = dE_e/d\omega$.

Case 3—On the path and in the direction of an element of a beam, in a nondiffusing, nonabsorbing medium, the radiance is also the quotient of the radiant flux $d\Phi_e$ which transports the beam, by the geometric extent dG of the beam. The geometric extent, which may be defined by two sections of the beam of areas dA and dA' of separation l, and having angles Θ and Θ' between their normals and the direction of the beam is $dG = dA \cos \Theta\ d\omega$ where the numerical value in steradians of $d\omega$ is $dA' \cos \Theta' l^{-2}$. $L_0 = d\Phi_0/dG = d^2\Phi_e/(d\omega\ dA \cos \Theta)$. In the absence of diffusion, it can be demonstrated in geometrical optics that the optical extent, product of the geometric extent of an element of a beam and the square of the refractive index of the medium of propagation, is an invariant along the length of the beam whatever the deviations that it undergoes by reflection or refraction ($dG \cdot n^2$ = constant). In consequence, the basic radiance, quotient of the radiance by the square of the refractive index, is invariant along the length of an element of a beam if losses by absorption or by reflection are taken as zero ($L_e \cdot n^{-2}$ = constant).

radiance factor at a point on the surface of a nonself-radiating body, in a given direction under specified conditions of irradiation**,** *n*—ratio of the radiance of the body to that of a perfect reflecting or transmitting diffuser, identically irradiated. Symbol: β.

radiant efficiency of a source of radiation, *n*—ratio of the radiant flux emitted to the power consumed. Symbol: η_e, η.

NOTE 23—The radiant efficiency of a source in a limited region of the spectrum may also be considered, that is, the ratio of the radiant flux emitted in this spectral region to the power consumed.

radiant energy, *n*—energy emitted, transferred, or received as radiation. Symbol: Q_e, Q; Unit: joule J (1 J = W·s).

NOTE 24—In ultraviolet radiation therapy and photobiology, this quantity is called "integral dose" (International Photobiology Committee, 1954).

radiant exposure at a point on a surface, *n*—surface density of the energy received. Symbol: H_e, H; $H_e = dQ_e/dA = \int E_e\ dt$; Unit: joule per square metre, $J \cdot m^{-2}$.

NOTE 25—Formerly "irradiation."

NOTE 26—Equivalent definition: Product of an irradiance and its duration.

NOTE 27—In ultraviolet radiation therapy and photobiology, this quantity is called dose (International Photobiology Committee, 1954).

radiant exitance at a point on a surface, *n*—quotient of the radiant flux leaving an element of the surface containing the point, by the area of that element. Symbol: M_e, M; $M_e = d\Phi_e/dA = \int_2 L_e \cos \theta d\omega$. Unit: Watt per square metre, $W \cdot m^{-2}$.

NOTE 28—The name radiant emittance previously given to this quantity is abandoned because it has given rise to confusion. Thus, the term "emittance" has been used to designate either the flux per unit area leaving a surface (whatever the origin of the flux), the flux per unit area emitted by a surface (flux originating in the surface), or, principally, in certain circles in the United States of America, a quantity without dimensions similar to "emissivity," but applicable only to a specimen.

NOTE 29—The expression "self-radiant exitance" ($M_{e,s}$) indicates that the flux considered does not include reflected or transmitted flux. The expression "thermal-radiant exitance" ($M_{e,th}$) indicates that the flux considered is produced by thermal radiation. These same adjectives (self, thermal) are equally applicable to other quantities, such as radiance, and so forth.

NOTE 30—In the case of a full radiator (blackbody), the radiance L_e is uniform in all directions. In consequence, when the solid angle is measured in steradians, the radiant exitance has the numerical value $M_e = \pi l_e$.

radiant flux: radiant power, *n*—power emitted, transferred, or received as radiation: Symbol: Φ_e, Φ, P; $\Phi_e = dQ_e/dt$; Unit: Watt (W).

radiant flux (surface) density at a point of a surface, *n*—quotient of the radiant flux at an element of the surface containing the point, by the area of that element. (See also **irradiance** and **radiant exitance**.) Unit: Watt per square metre, $W \cdot m^{-2}$.

radiant intensity of a source, in a given direction, *n*—quotient of the radiant flux leaving the source propagated in an element of solid angle containing the given direction, by the element of solid angle. Symbol: I_e, I; $I_e = d\Phi_e/d\omega$; Unit: Watt per steradian, $W \cdot sr^{-1}$.

NOTE 31—For a source that is not a point source: The quotient of the radiant flux received at an elementary surface by the solid angle which this

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