Toward a Unified Nomenclature in Fluorescence Spectrophotometry

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Abstract

The measurement of fluorescence has applications spanning analytical chemistry and materials science as well as photometry and colorimetry. Each of these diverse disciplines has evolved its own specialized system of nomenclature, with varying degrees of standardization. All of these applications share similar fundamental principles of measurement, but there are significant differences in the way that measurands are defined. No comprehensive and consistent system of nomenclature has yet been established that encompasses the full range of such applications. This paper presents a provisional unified nomenclature for fluorescence spectrophotometry, which is designed to support a discussion of common principles of fluorescent measurement across various disciplines, and to clarify the differences among them. The key terms and notation proposed are summarized in the tables below.

In order to demonstrate the versatility of the proposed system of nomenclature, this paper develops, from basic concepts, an explanation of the spectral and bispectral dimensions of fluorescence, and the various approaches to quantifying fluorescence "intensity." Concepts such as internal and external yield, quantum and radiant efficiency, radiance factor, and bispectral radiance factor are reviewed, supplementary terms are introduced, and conventional terminology from various disciplines is reconciled with the proposed, unified system.

Table I: Unispectral Quantities: Dimensionless functions of excitation wavelength (μ). Note that each of these quantities comprises both a luminescent component and a non-luminescent component.

	EXTERNAL		INTERNAL	
	Quantum	**Radiant**	**Quantum**	**Radiant**
Yield	$\gamma_p(\mu)$ external quantum yield	$\gamma_e(\mu)$ external radiant yield	$\varphi_p(\mu)$ internal quantum yield	$\varphi_e(\mu)$ internal radiant yield
Yield Factor	$G_p(\mu)$ (external) quantum yield factor*	$G_e(\mu)$ (external) radiant yield factor		

**External quantum luminescent yield factor* ($G_{p,L}(\mu)$) is equivalent to *spectral quantum efficiency of the fluorescent process* ($\eta_\mu(\mu)$□□, as defined in the International Lighting Vocabulary of the CIE (Pub. 017:2011).

Table II: Bispectral Quantities: Spectral concentrations with respect to (λ) of functions defined above. Note that each of these quantities comprises both a luminescent and a non-luminescent component.

	EXTERNAL		INTERNAL	
	Quantum	**Radiant**	**Quantum**	**Radiant**
Yield	$\gamma_{p,\lambda}(\mu,\lambda)$ external bispectral quantum yield	$\gamma_{e,\lambda}(\mu,\lambda)$ external bispectral radiant yield	$\varphi_{p,\lambda}(\mu,\lambda)$ internal bispectral quantum yield	$\varphi_{e,\lambda}(\mu,\lambda)$ internal bispectral radiant yield
Yield Factor	$G_{p,\lambda}(\mu,\lambda)$ (external) bispectral quantum yield factor**	$G_{e,\lambda}(\mu,\lambda)$ (external) bispectral radiant yield factor**		

***External bispectral luminescent yield factor* ($G_{L,\lambda}(\mu)$) is closely related to *bispectral luminescent radiance factor* ($\beta_{L,\lambda}(\mu)$, as defined in the International Lighting Vocabulary of the CIE (Pub. 017:2011).

References

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Author Biography

Jim Leland is the Principal at Copia LLC, Consultants in Optical Science. He has worked in the fields of radiometry, photometry, colorimetry, and spectrophotometry for over twenty-five years, including service at Gamma Scientific and Labsphere, Inc. He holds an MS in Imaging Science from RIT, and studied Physics and Philosophy at Princeton University. He is a member of the IES-TPC, ISCC, OSA, and SPIE. He is chairman of ASTM Committee E12, and is an officer of CIE-USA and CORM.