PhytoPhotonics

Real-time Passive Fluorescence Spectra of Induced Stress in Vegetation

Arnold F. Theisen, Ph.D.

Dawn of Fluorescence Remote Sensing

Fixed-wing imaging radiometer (above)

Helicopter mounted radiometer (right)

{ Three wavelengths, one at a time }

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Down to Earth Fly-over Imaging
(one wavelength: 656.3 nm)

Drought Study Components
Canopy Fluorescence
vs
Stomatal Resistance
r = 0.80 (P ≤ 0.05)

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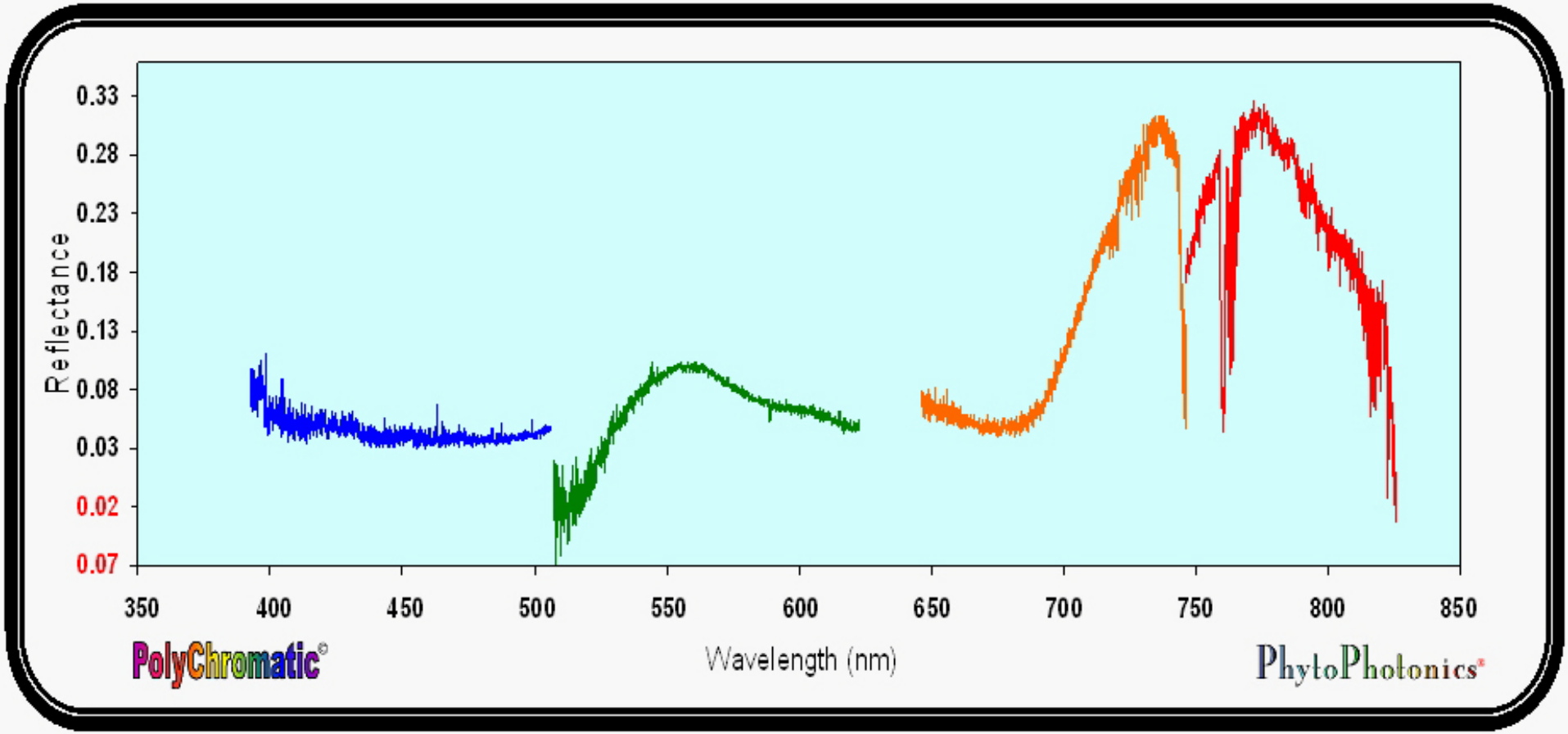
Today: Using the Full Solar Spectrum

Data collection and analysis systems can generate fluorescence spectra from the same information used to produce reflectance spectra.



Reflectance of grass prior to treatment

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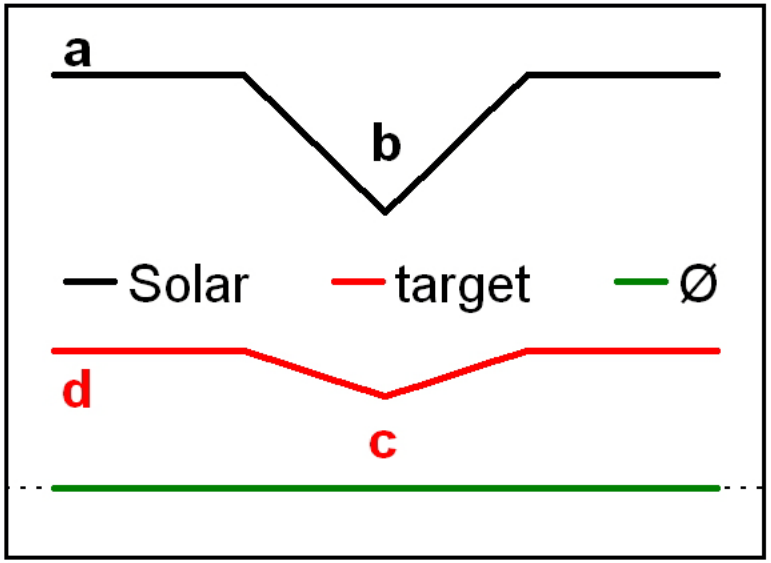
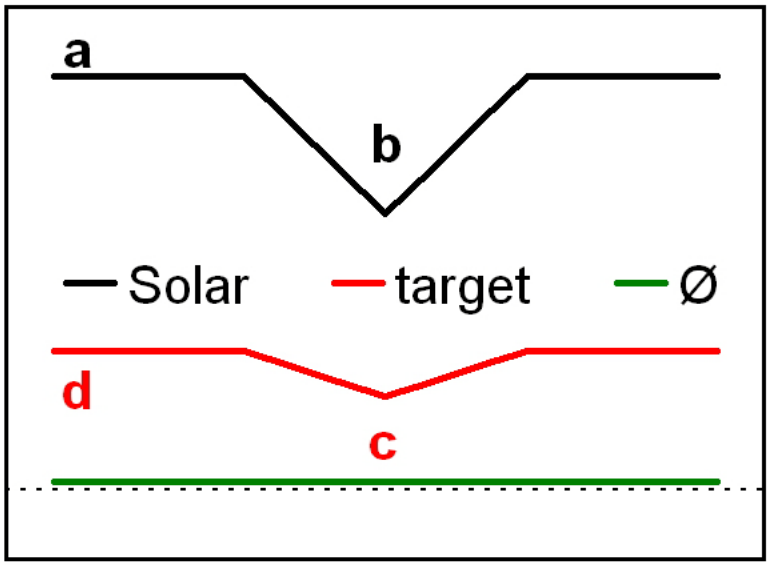
Fluorescence is derived from raw spectral data using the formula established by J.A. Plascyk (1975); F = d/a – (d-c) / (a-b), where a is the solar continuum intensity, b is line center intensity, c is target intensity, and d is target continuum intensity.

Non-fluorescent target



Reflectivity = 33.33%
Reflectance = 33.33%
Fluor. Coeff. Ø = 0.00%
Fluorescence = 0.0000

Typical fluorescent target



Reflectivity = 33.33%
Reflectance = 33.66%
Fluor. Coeff. Ø = 2.00%
Fluorescence = 0.0033

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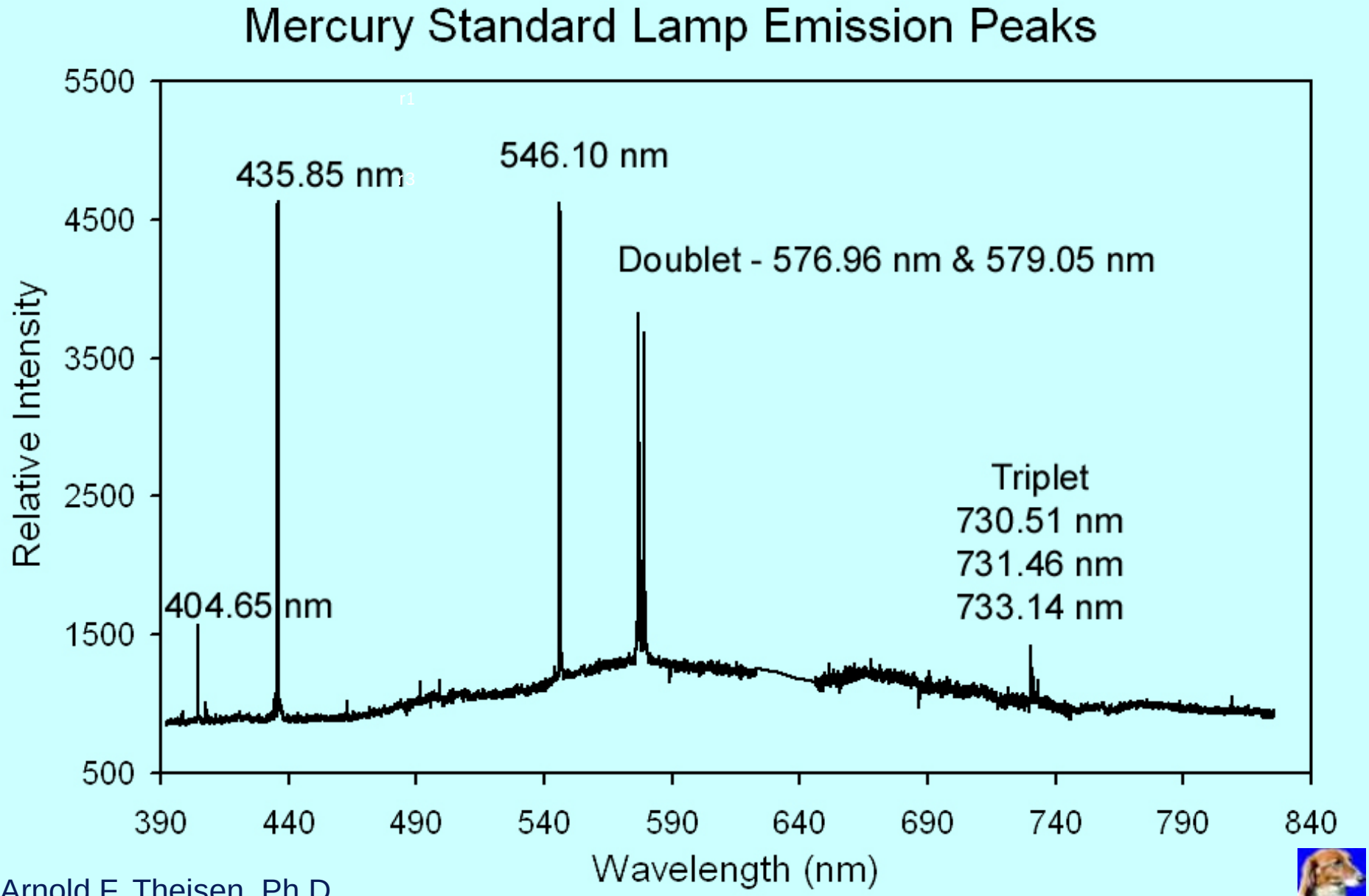
Instrument calibration source



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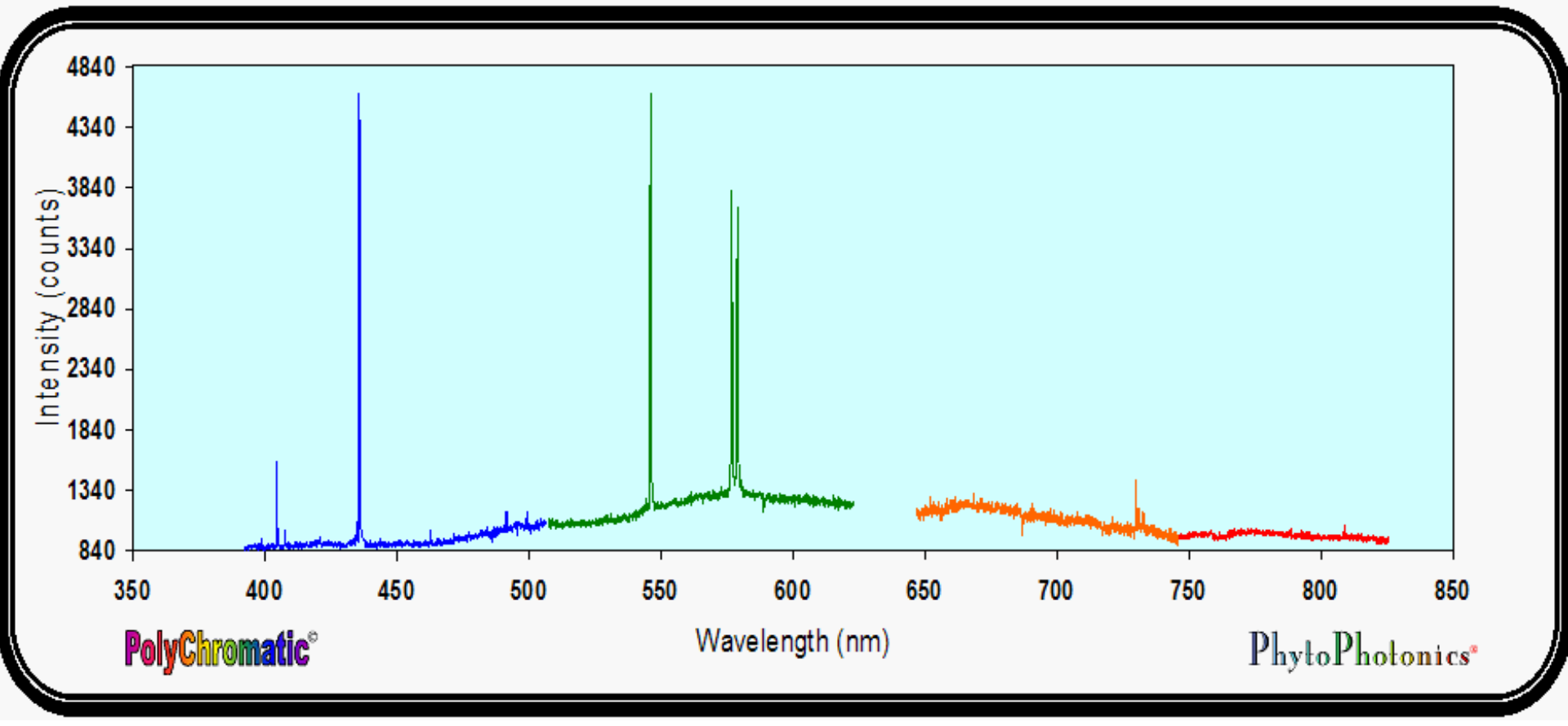
Instrument calibration source

The same spectra from the mercury lamp as seen in the previous slide is shown below. This is how it looks on the screen of the controlling laptop for the field instrument.



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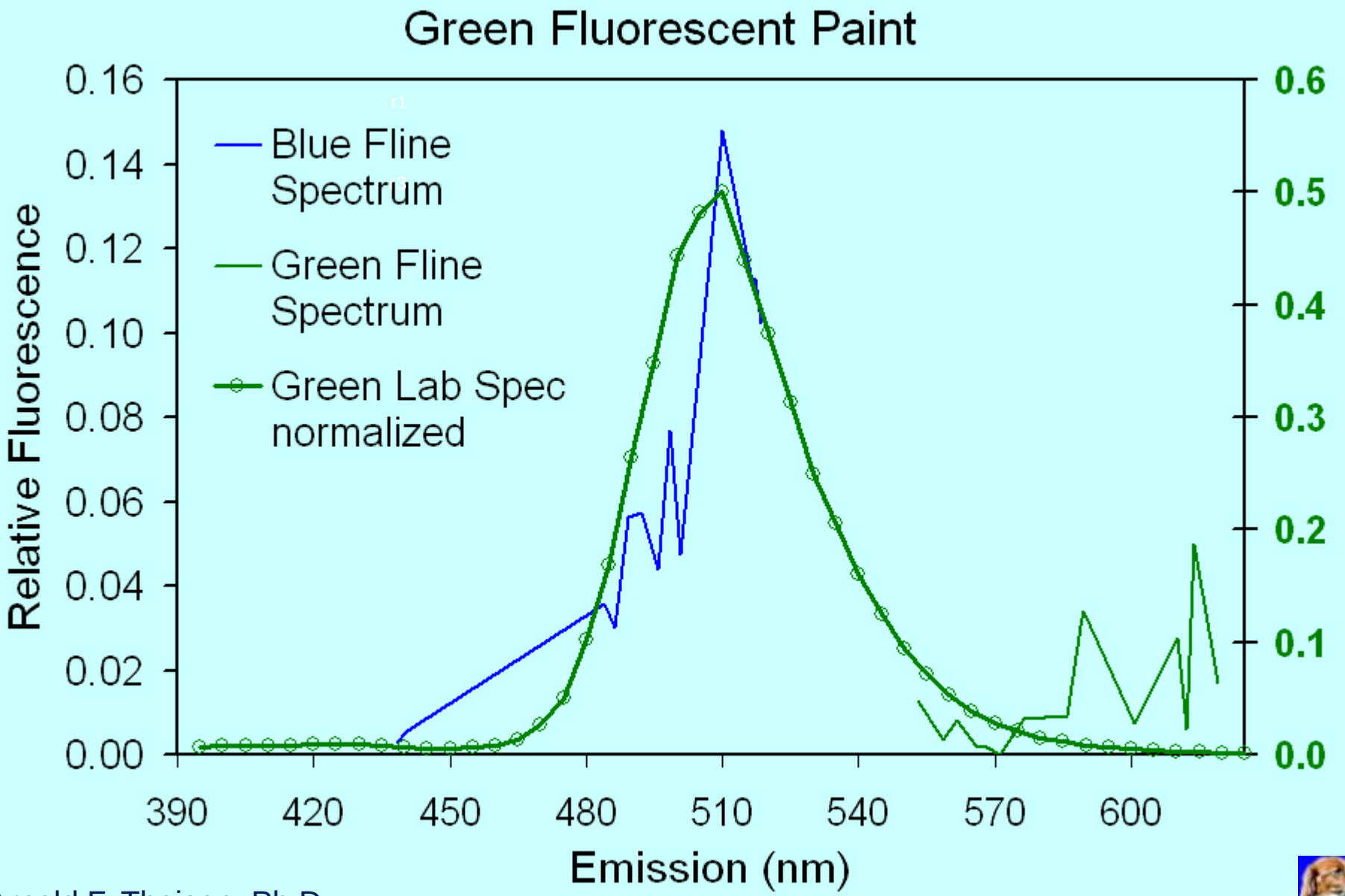
Spectral validation - fluorescent paints.



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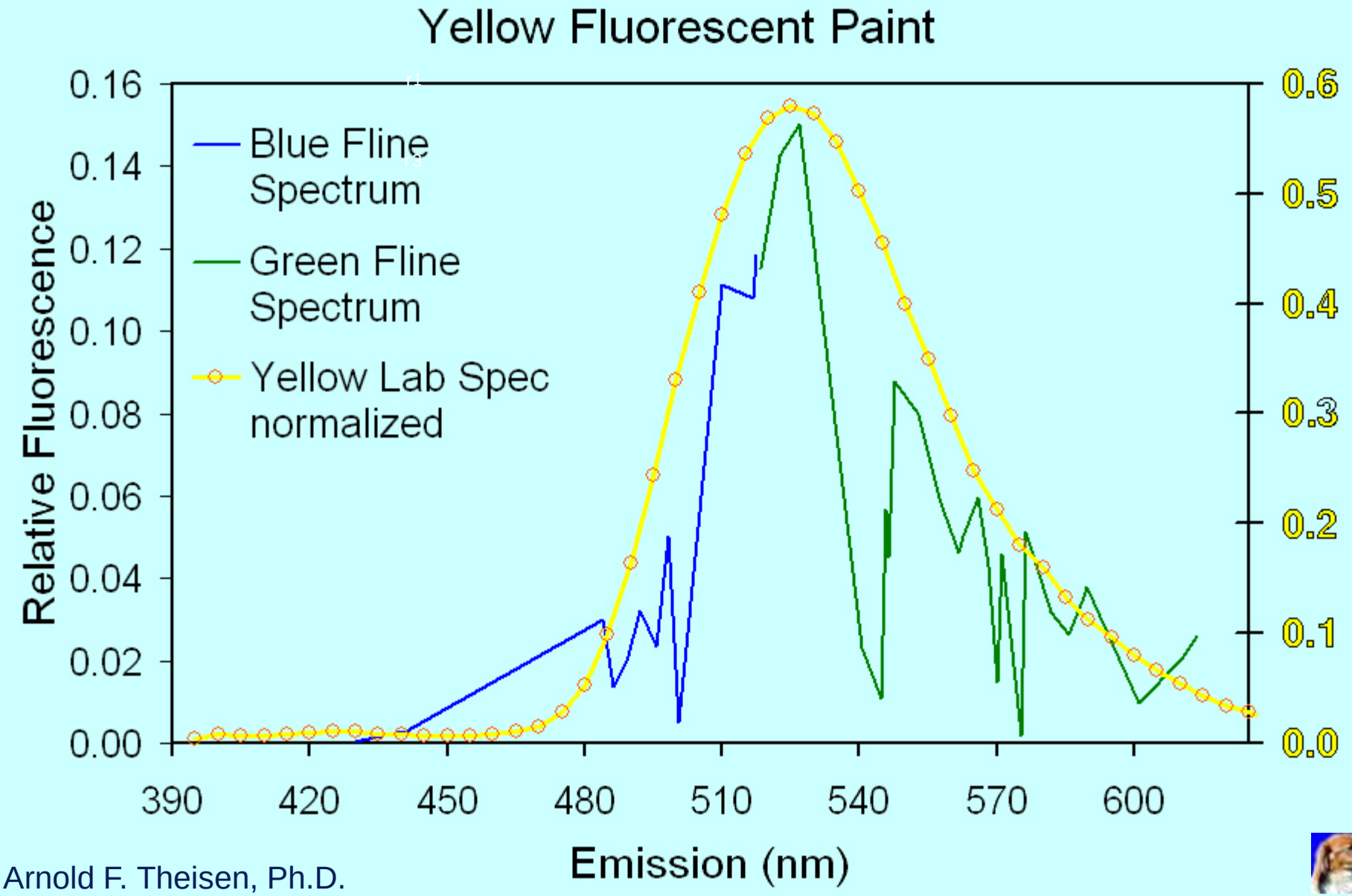
Spectral validation - fluorescent paints.



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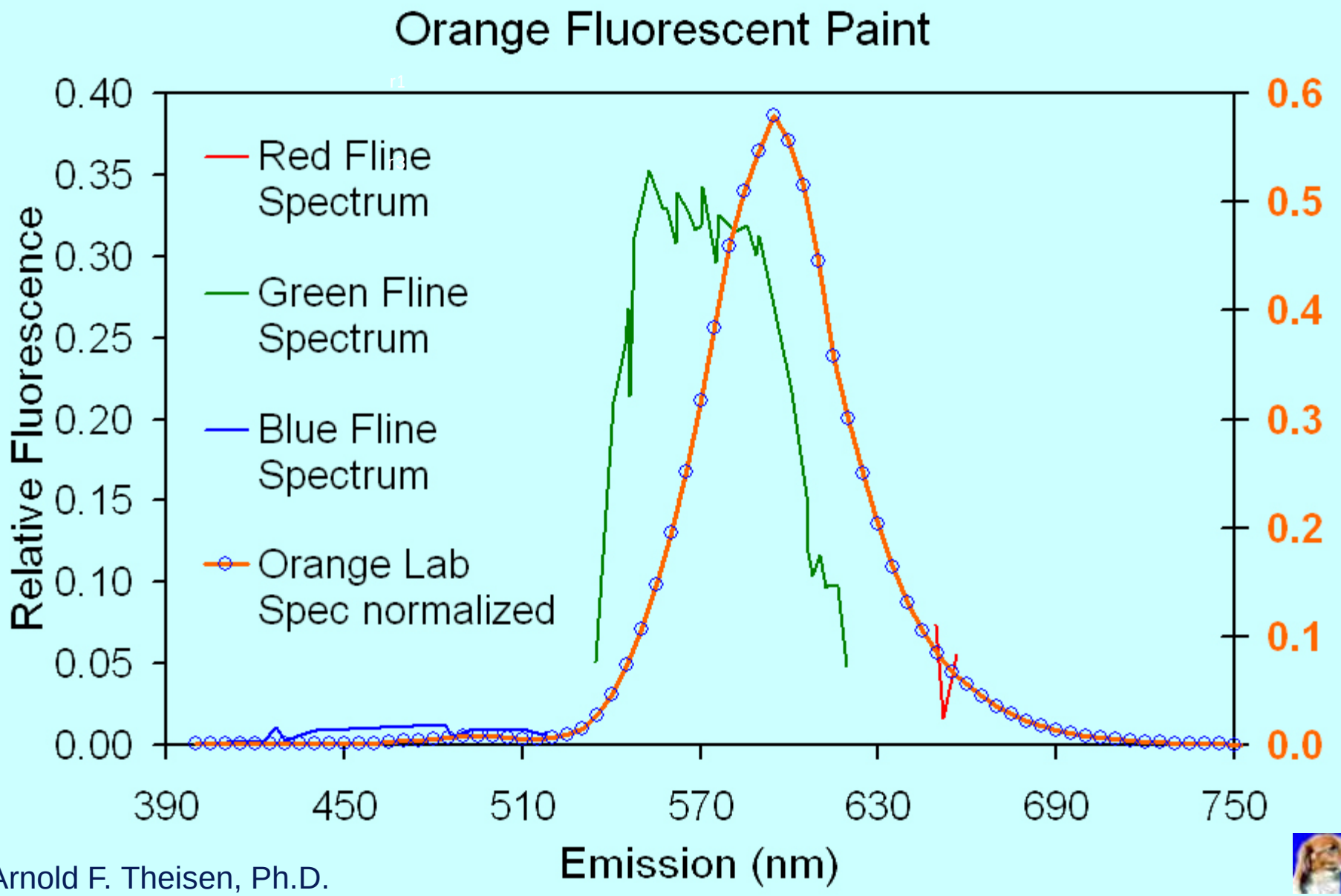
Spectral validation - fluorescent paints.



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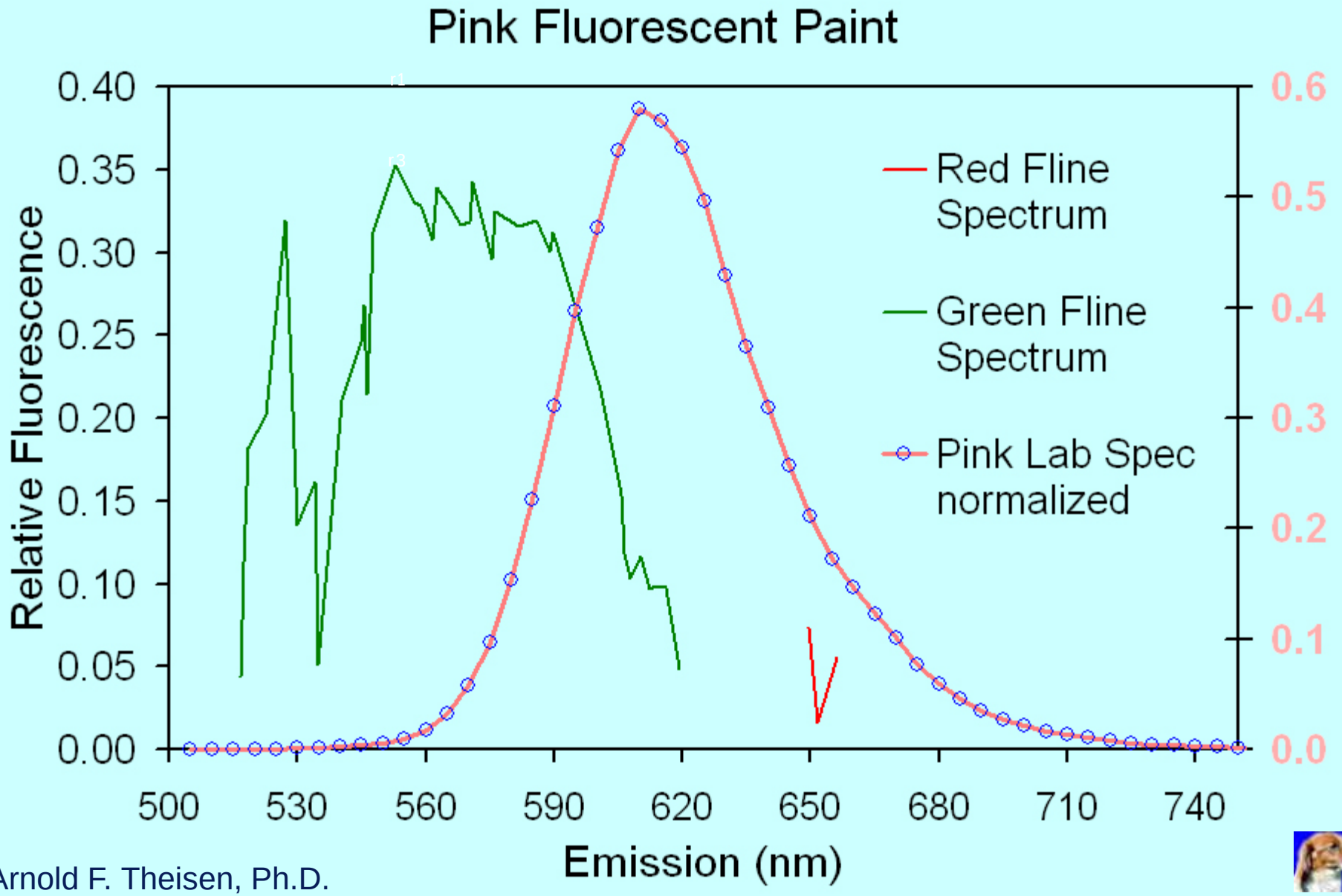
Spectral validation - fluorescent paints.



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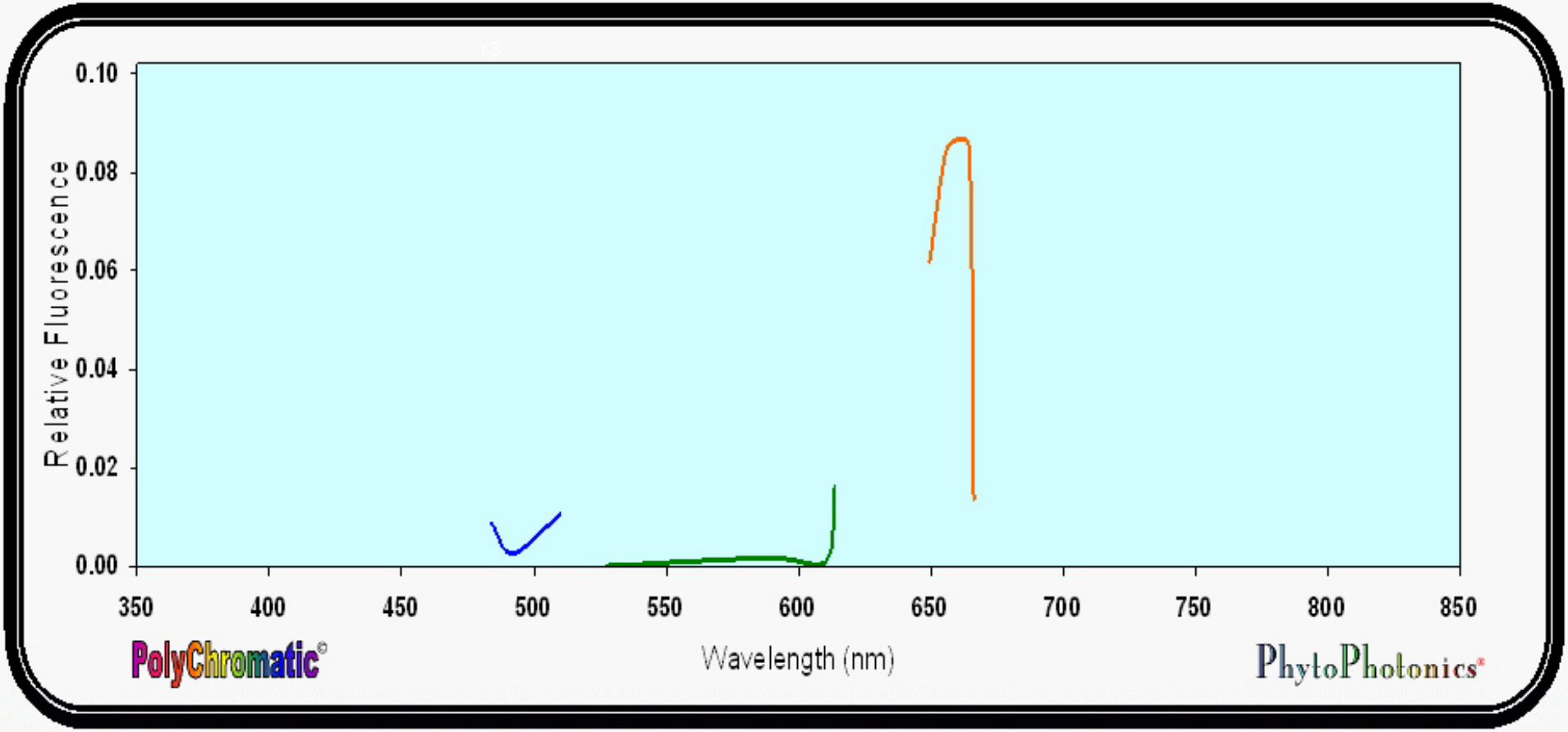
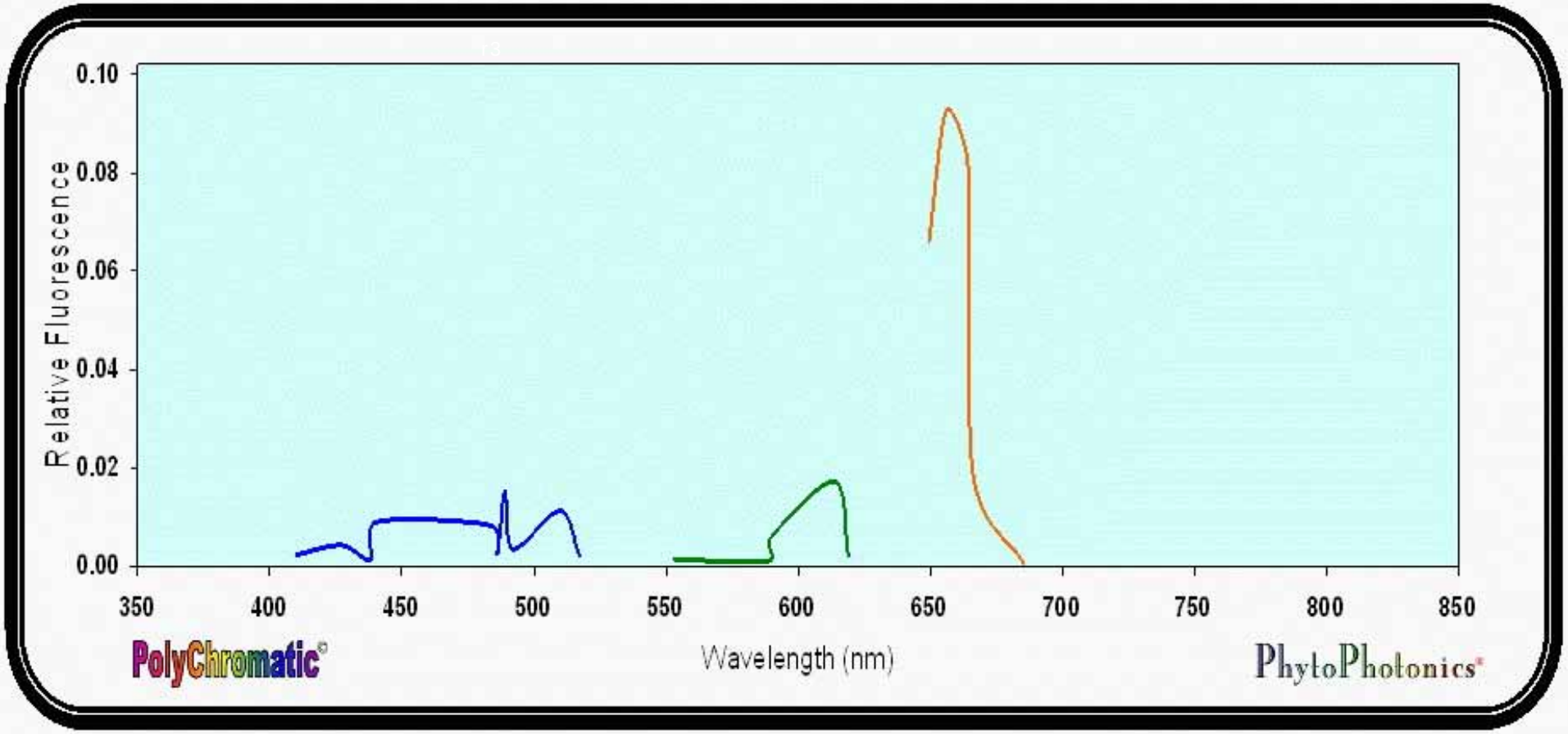
The spectra shown below reveal the expected emissions from normal healthy vegetation. There are minor levels in the blue and green, and higher levels in the red.



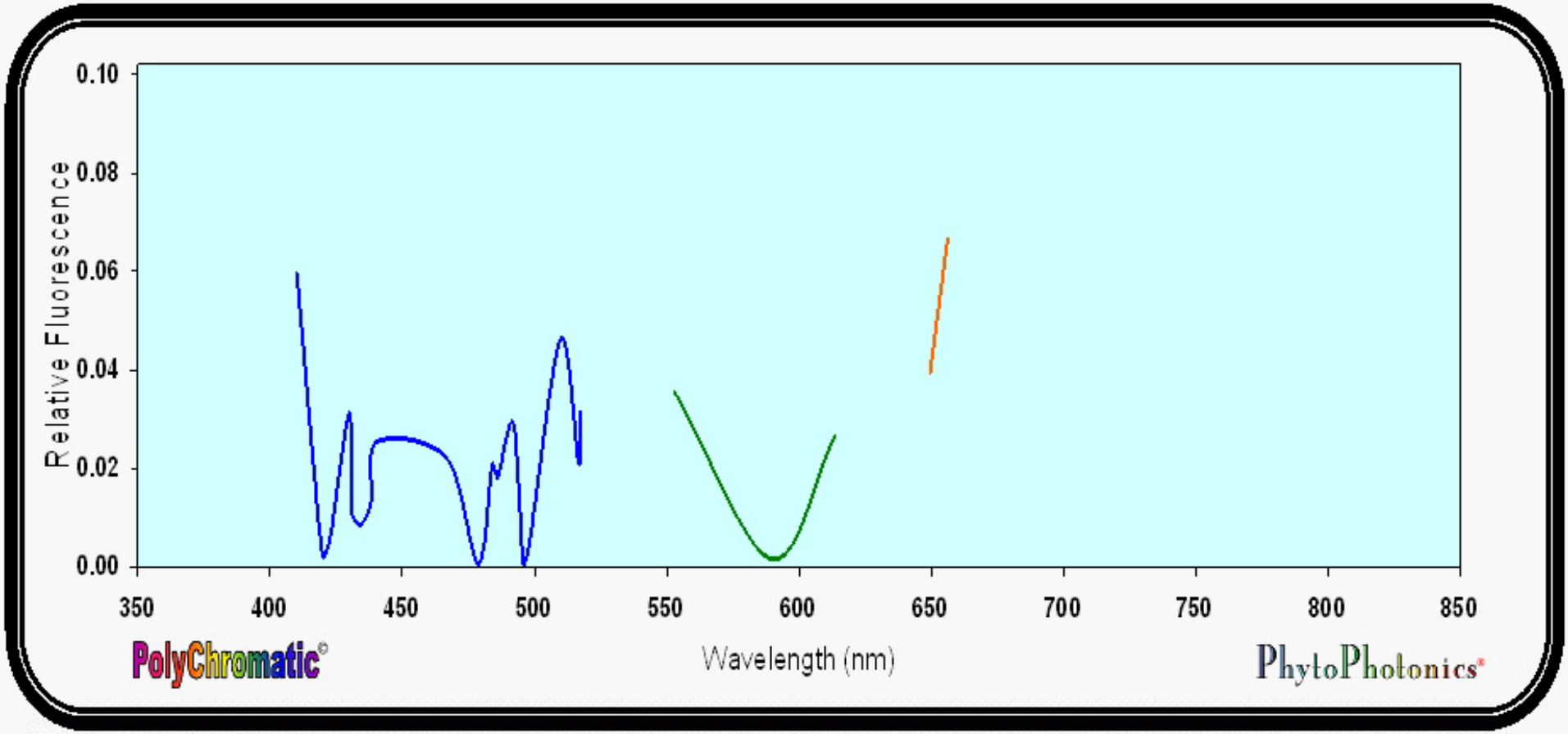
Fluorescence of grass prior to treatment.

Immediately after treatment with atomized oil, the levels in the blue and green have already increased, while the red levels have remained relatively unchanged.



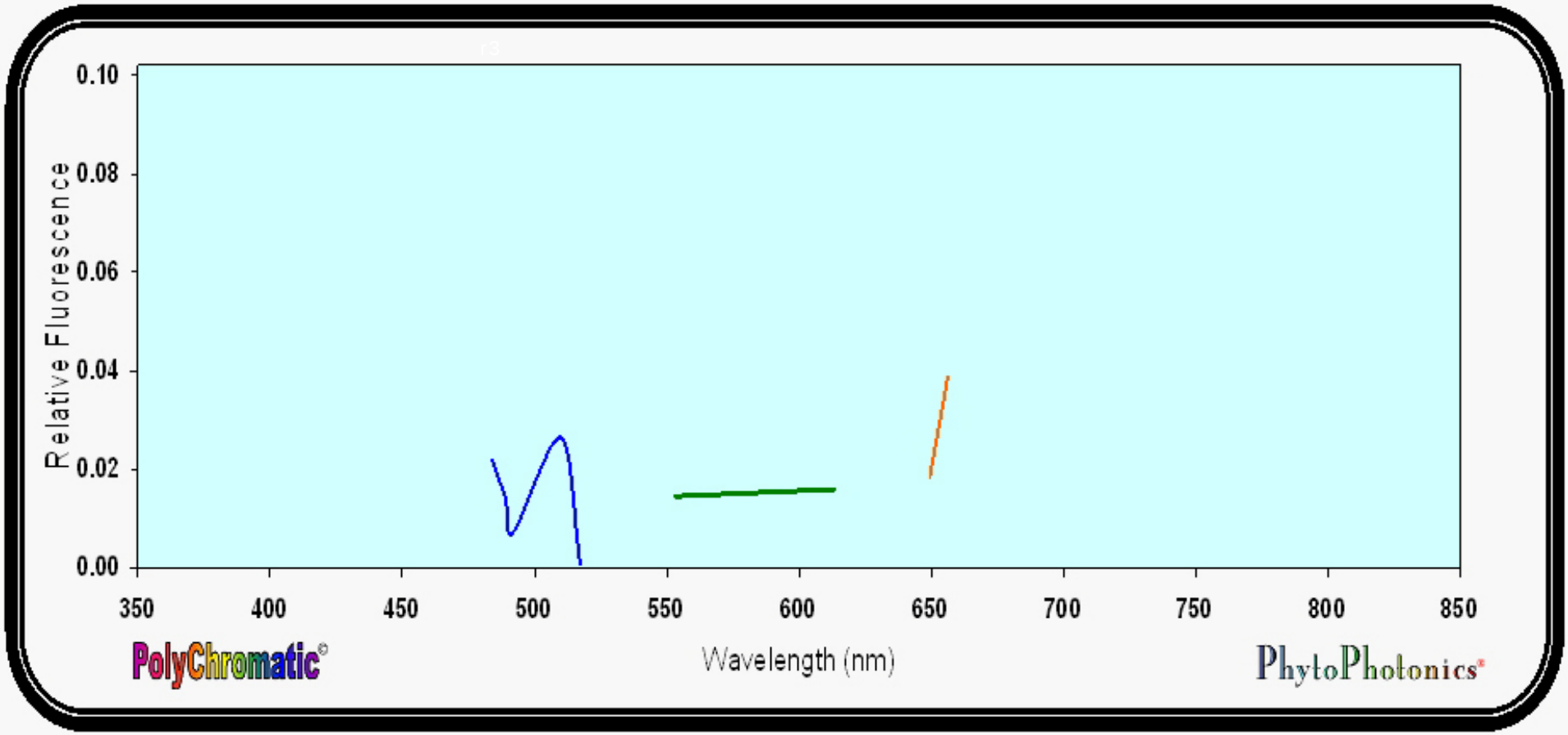
Fluorescence of grass immediately after treatment.

Ninety minutes later, the levels in the blue and green have increased significantly. Much of the longer wavelengths of the red peak are gone, leaving a signal 50% of the original.



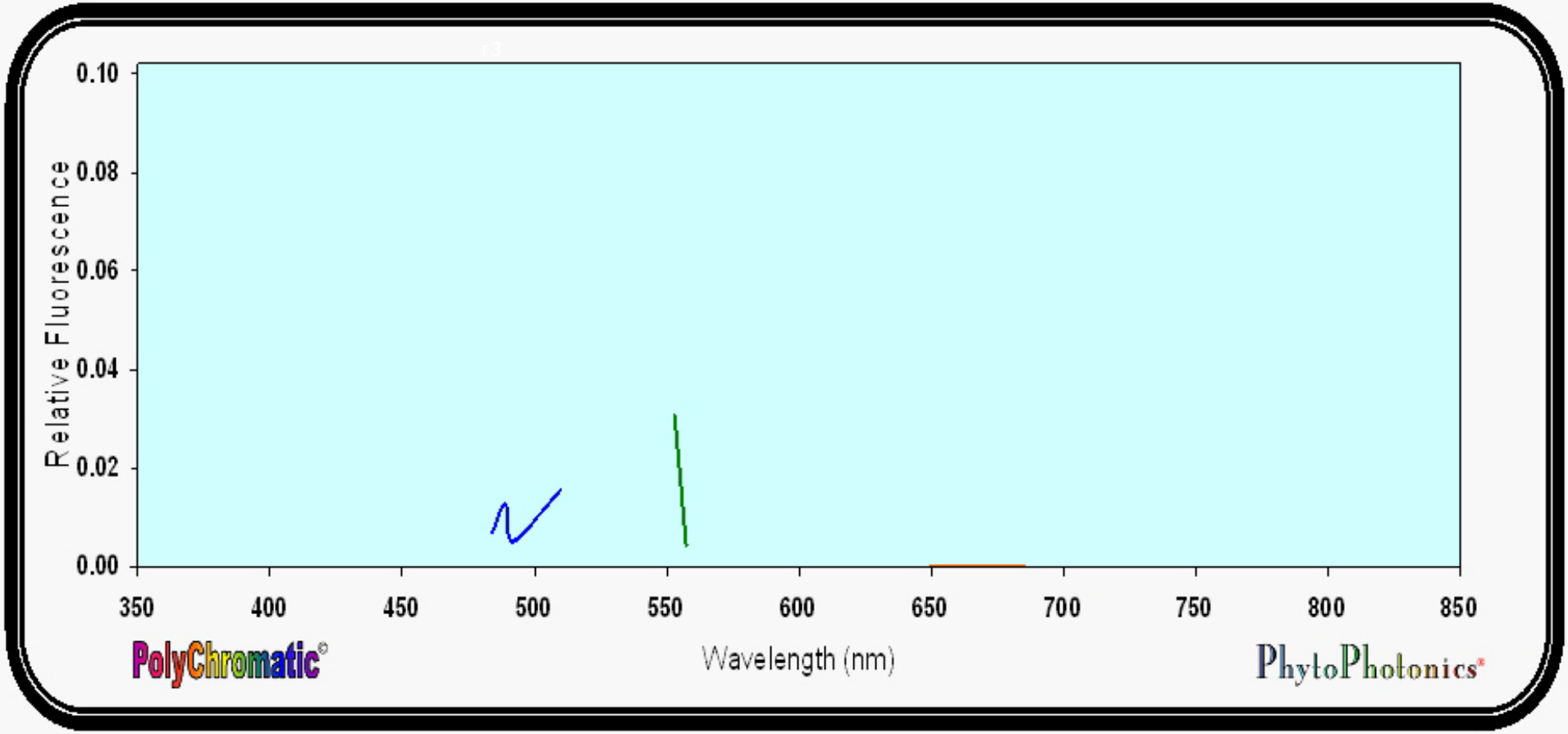
Fluorescence of grass 1½ hours after treatment.

One more hour and the levels in the blue and green have dropped significantly again, the red peak has decreased too, and the spectra looks similar to that of dead grass.



Fluorescence of Grass 2½ hours after treatment.

Nature provided a convenient alternate site near to the test plot so that untreated dead grass could be measured for comparison. The zero red signal is hard to see in this chart.



Dead grass.

WRAP UP

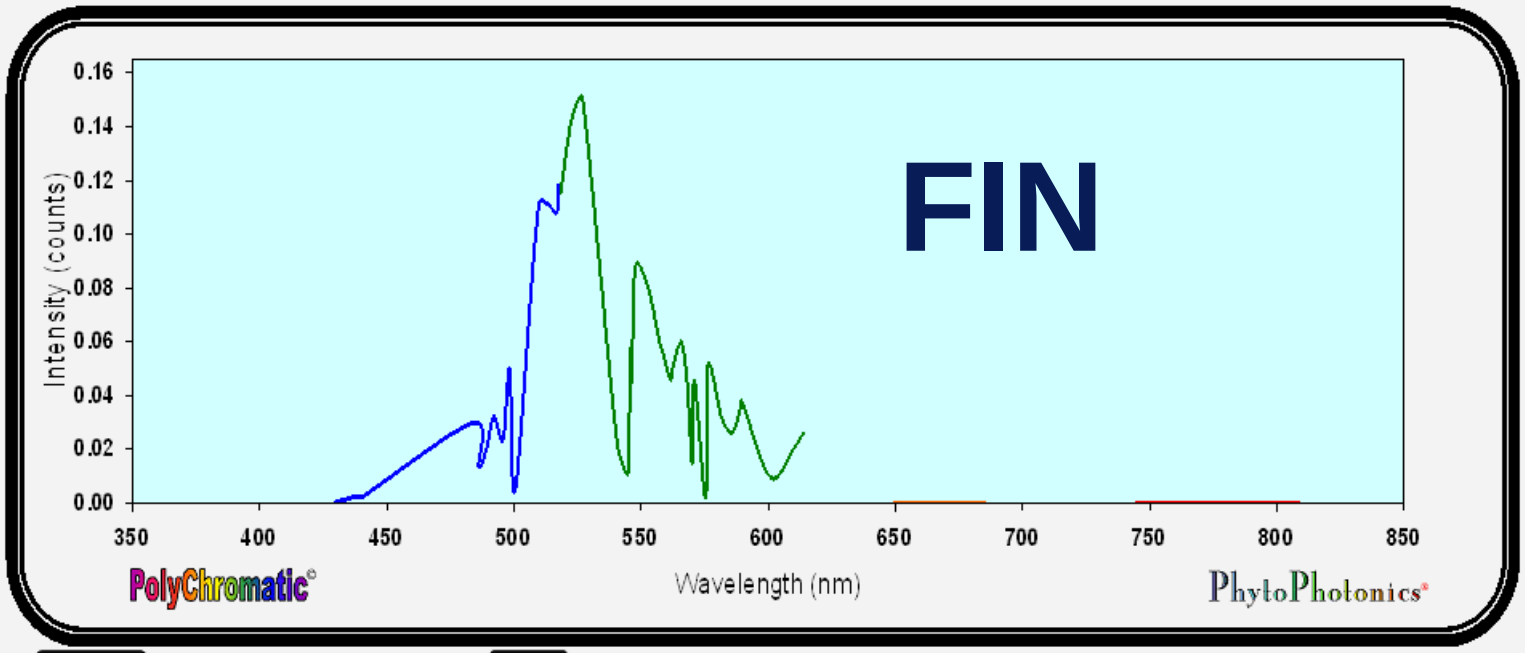
The spectral progression shown in the preceding slides are expected indications of severe stress and photosynthetic shut down. The data for this test are spread out in time, and therefore, the next test will concentrate on acquiring the full transition from one state to the next at intervals of 5 to 10 seconds. This non-invasive method for the spectral observation of non visual damage eliminates the potential that other sources of stress contribute to the end results.

WRAP UP (cont.)

In addition, reflectance spectra, as seen in the first plot, is produced from the same raw data. It can be analyzed later or the desired end products can be programmed into the instrument to provide a choice of algorithms for real-time display.

The field instrument has been used to successfully measure many materials in addition to vegetation. We also have an extensive catalog of spectra from a wide variety of materials measured in the laboratory.

Yellow Fluorescent Paint



Change Y-Axis

INCREMENT AND SAVE EXCEL FILE

Full Screen Toggle

INITIALIZE

Single Unit Data Collection					
	BLUE	GREEN	RED	FARRED	0
					IN USE
					Disabled
					UNIT #
ALL ITs	180	180	180	180	IT (msec)
ALL REPs	10	10	10	10	REPS

Maker's use only ▶ Calibrate ▶ ReSet

Full Spectrum Data Collection			
Dark	Light	Raw	Reflct

Spectrum Display Selection			
Default	Raw	Light	Reflect
Spline ⇑	Spline ⇓	Fline Spectra	Abs Irrad

Displaying Fluorescence Spectra

SAVE IMAGE

SAVE TEXT SPECTRUM

SAVE FLINE

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