The Colour of Electrons and the CCD

By Charles Douglas Wehner

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The world of physics is a strange world indeed.

At the end of the nineteenth century it was found that a negatively charged metal plate would discharge when illuminated, but a positively charged one would not.

Then it was found by some researchers that NO metal plate would discharge.

Other researchers found that red light had no effect, but blue discharged the plate.

The "photoelectric effect" was a mess.

Max Planck discovered that light consisted of particles. And each particle (or quantum) had an energy that could be defined as Joules.

The science was very simple. Take the frequency of that light particle, multiply by Planck's constant, and you find how many Joules of energy are in that particle.

You could even pretend that this light particle collided with an electric particle − the electron. If so, it would transfer its energy to that electron in just the same way as the chemistry of a battery energises electrons.

So we could define the near infra−red as 1.7 electron volts, and at the other end of the spectrum ultra−violet begins at 3.2.

For this he got the Nobel prize.

With the electron−voltages of light being now defined, Einstein decided to tackle the problem of the metal plate. Why was it that only NEGATIVE electricity would be discharged? Because there is only one kind of "charge−carrier". Or so it seemed at the time.

Why did some researchers find that NO metal plate would discharge? Because the voltages are LOW. Even the slightest film of grease or dirt could INSULATE against less than 3.2 volts.

And why did blue light work when red did not? The answer lay in Planck's electron voltages.

Einstein discovered that the effect varied with the TYPE of metal used for that plate. Each element, sodium, potassium, iron, copper, the noble metals such as platinum &c., had a unique voltage.

That voltage represented the energy that had to be present in the light in order to free the electrons.

That voltage became known as the WORK FUNCTION.

Knowing this, scientists began to research the forces that hold atoms together. In the technical literature, Einstein's name was cited so often that the Nobel Prize Committee could not ignore it.

So Einstein won the Nobel Prize.

It is true that further researches modified the simple model that scientists had used. For example, the particle model of Planck suggested that an ultra−violet "PHOTON" could travel for thousands of millions of years through space, retaining its 3.2 eV energy − and NEVER become two photons at 1.6 eV each.

This is the LAW OF CONSERVATION OF MATTER.

But after that huge journey, it needs only for that photon to hit a suitable crystal and it does indeed divide. You get TWO photons for the price of ONE. This is only possible if the photon consists of NOTHING.

So the wave model of light began to supervene. Waves consist of nothing but a pattern. And questions were asked as to whether there is a SUBSTANCE in which the waves are formed. Does space consist of aether?

In some of my work I have reintroduced the concept of aether, but not as a SUBSTANCE. To me, there is a need for a grid of lines in space, for navigation. As on a map there is latitude and longitude (which are not substances), so in space we need a kind of latitude, longitude and altitude. Without that we get lost.

But the question of whether light is particles or waves was never resolved. Sometimes it behaves as one, and sometimes as the other.

Again, the concept that there is only one kind of charge−carrier has been overthrown. In solids there can be positive, negative or both.

A conductor conducts both charge−carriers. A vacuum conducts only the negative ones. So a vacuum is an N−TYPE SEMICONDUCTOR.

The discovery of semiconductors led to huge advances in the field of electronics. There are P−TYPE as well as N−TYPE semiconductors, and a remarkable symmetry of behaviour can be seen between them.

So light is like a particle in the VACUUM STATE, and shows the properties of a wave in the SOLID STATE.

Bizarre!

My interest in these things is not amusement alone. Wherever profound discoveries are made, profound new benefits to Mankind become possible.

If a metal is used for that photocell plate, that needs 1.5 volts, and infra−red shines upon it at 1.7 eV, electrons emerge at 0.2 volts.

If the light is at 2.5 eV, the "secondary electrons" will have 1 volt of charge. If the light is blue, at 3 volts, the elctrons will have 1.5 volts. It is a simple subtraction process. That is Einstein's photoelectric

effect.

So with a field plate charged to minus 0.2 volts, we can push back the "infra−red electrons". With minus 1 volt on the plate, we can push back the yellow ones. With minus 1.5 volts, we can push back even the blue electrons.

Infra−red electrons? Yellow electrons? Blue electrons? In reality, these things are not their colours but their speeds. For each electron retains the energy that was left over after the Einstein Work−Function was subtracted from the photon.

This makes the colour sensitivity of a digital image−sensor PROGRAMMABLE. Instead of having red, green and blue filters on an image sensor, we can have NO FILTERS.

Digital techniques are used to analyse the colour of the image. The benefits are enormous.

For example, we live in a world of daylight and artificial light. Daylight is rich in blue, tungsten light is rich in red. When the colour balance of the device depends not upon chemical filters with their fixed colours, but upon software, the device can better adapt to the lighting.

You can read about this new concept in CCD image sensor design at http://www.wehner.org/electro/einstein/ . Seven related inventions are also described, to help the design along.

Charles Douglas Wehner

Born in 1944, Charles Douglas Wehner was a factory manager, design engineer and technical author in photoelectrics.

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