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Discovery

# Bharat radiation and UV dominant optical radiation emissions discovered from radioisotopes and XRF (X-ray fluorescent) sources

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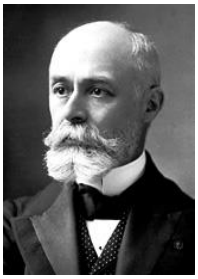
## 1. LATEST DISCOVERIES IN NUCLEAR AND X-RAY PHYSICS, ATOMIC SPECTROSCOPY, AND SOLAR PHYSICS

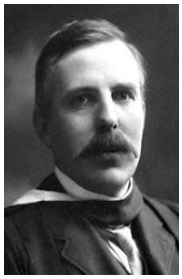
### 1.1. What is already known?

In 1896, Antoine Henri Becquerel discovered the phenomenon of natural radioactivity from potassium uranyl sulfate salt. When the salt was subjected to magnetic field, the radiation he detected has negative, positive, and electrically neutral charges. Marie Curie termed 'radioactivity' to the phenomenon of these new emissions. Ernest Rutherford, who studied the properties of radioactive decay named these three radiations as alpha, beta, and gamma. While brilliant phosphorescence from the chemical compound potassium uranyl sulfate is well documented, fluorescent light emission from individual excited atoms in artificially produced radioisotopes remained elusive to previous researchers.


Henri Becquerel


Marie Curie


Pierre Curie


Ernest Rutherford

## 1.2. New Physics

Over a century later to the discovery of radioactivity by Henri Becquerel, the author has discovered two generations of γ, β and X-ray emissions, namely Bharat Radiation followed by UV dominant optical radiation from within the one and the same excited atom of a radioisotope or XRF source by Padmanabha Rao Effect, a previously unknown phenomenon,

The experimental set up is a simple Gamma ray Spectrometer from Electronics Corporation of India, Hyderabad, India. The successful detection of UV dominant optical radiation from radioisotopes and XRF sources owes to setting gain of the linear amplifier to be slightly higher than what is required normally to a scintillation detector.

The success of light detection also owes to directly keeping the XRF source (AMC 2084, U.K.) on the photomultiplier tube 9635QB (PMT), Thorn EMI as shown above. The probe consisting of this photomultiplier tube and preamplifier was kept in a metal container and tightly covered so as to be free from any light leak.

## 1.3. A surprise finding led to these new findings in Physics

Many of the discoveries in science resulted from an unexpected finding. A surprise finding, Rb XRF source (AMC 2084, U.K.) showing 125,321 cps instead of the expected 4,400 Rb X-ray photon yield sec-1 0.5 steradian-1 triggered this entire study just to unfold why these spectacularly high counts. In the absence of prior theory or any experimental study on the subject, further experiments incredibly suggested the possibility of optical radiation with low quantum yield from the source.

## 1.4. Why previous researchers failed to detect the optical emission?

There are further reasons why optical emission has evaded from previous researchers all these years. Firstly, the dominant UV not only invisible like ionizing radiations but also follows the later from one and the same source. Secondly, photomultiplier tube simultaneously detects γ, β, and X-ray emissions as well as UV, visible (VIS), and near infrared (NIR) radiation emissions.

## 1.5. Three Experimental Discoveries

After 4 years of experimental research at the Defence Laboratory, Jodhpur, Rajasthan State in India , author suspected that optical radiation might be the cause for excessively high counts from Rb XRF source, but unsure whether it was merely luminescence. Another two years were spent in developing two elegant optical techniques using narrow band optical filters in one technique and a pair of sheet polarizers in another technique that greatly helped in providing first and definite evidence on light emission and in estimating very low UV, VIS, and NIR radiation intensities despite the interfering ionizing radiations. Essentially these techniques led to a key finding that γ, β, or X-ray emission commonly causes UV dominant optical emission from the same excited atom in a radioisotope or XRF source. This experimental research led to three fundamental discoveries significant to X-ray physics, nuclear physics and atomic spectroscopy.

**Irène Curie**

# 2. DISCOVERY 1: UV DOMINANT OPTICAL EMISSION NEWLY DETECTED FROM RADIOISOTOPES PRESENT AS RADIOCHEMICALS

Ever since the synthesis of new artificially produced radioisotopes by Irène Curie and Frédéric Joliot, optical emission was never reported from radioisotopes by previous researchers.

## 2.1. New to Nuclear Physics

Radioisotopes are available either in the form of a salt called radiochemical or as a metal. For the first time, the author has experimentally detected very weak UV dominant optical emission invisible to the naked eye from all the radiochemicals tested such as $^{55}$Fe, $^{113}$Sn, $^{131}$I, $^{137}$Cs, and $^{90}$Y with an exception of $^{3}$H [1-9]. These radiochemicals have shown emission of an unprecedented nature of optical spectrum, dominated by UV to the extent of 83 to 97% in gross light intensity, while this % UV depends upon γ-, X-ray, or β energy. For example, low energy (0.02421 MeV) of dominant Indium X-rays of $^{113}$Sn caused UV as high as 96.95%, while visible (VIS) and near infrared (NIR) radiation intensities remained low at 2.21 % and 0.84% respectively [1]. Similarly, low energy γ of $^{241}$Am has caused 98.03% (UV), while VIS and NIR radiation intensities remained low at 1.91% and 0.06% respectively. In contrast, high energy β from $^{90}$Y caused just UV (83.36%), while VIS and NIR radiation intensities rose correspondingly to 8.02% and 8.62% respectively. Optical emission from radiochemicals has fundamental significance to nuclear physics, and simultaneous measurement of γ-, X-ray, β and optical intensities help in more accurate estimation of tracers than ever before.

**Wilhelm Conrad Röntgen**

**Charles Glover Barkla**

# 3. DISCOVERY 2: UV DOMINANT OPTICAL EMISSION FROM XRF SOURCES PRESENT AS SALTS

W.C. Roentgen has discovered X-rays from discharge tube in 1895. These X-rays known as bremsstrahlung radiation or continuous X-rays are widely used in Hospitals for diagnostic purposes. However, light emission following X-rays from X-ray tubes remained elusive to previous researchers. In the later years, C.G. Barkla has discovered characteristic X-rays of elements. These X-rays are called XRF (X-ray fluorescence). Variable Energy X-ray Source (AMC 2084, U.K.) of the size of a lemon used in the current study was manufactured with an intend to provide Rb, Ba and Tb X-rays with different energies from Rb, Ba and Tb XRF sources present as Rb, Ba and Tb salts on incidence of intense gamma beam from $^{241}$Am. The source also provides Cu, Ag, and Mo X-rays with different energies from Cu, Ag, and Mo XRF sources present as Cu, Ag, and Mo metals. Light emission remained elusive to previous researchers from any XRF source.

### 3.1. New to X-ray Physics

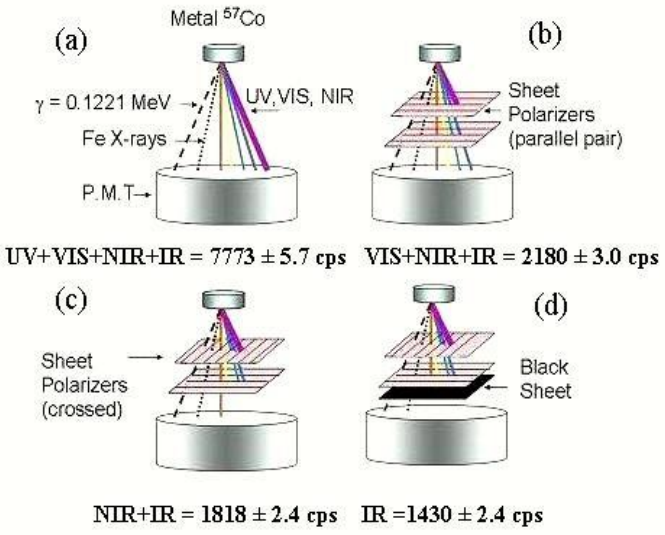
Characteristic X-rays (XRF) causing UV dominant optical emission by a previously unknown atomic phenomenon is new to X-ray physics. Of all the sources tested, the maximum UV dominant optical intensity has come from Rb XRF source. The low 0.013336 MeV Rb X-ray energy could cause the maximum UV (99.62%) intensity, while VIS (0.37% ), and NIR (0.01%) radiation intensities remained very low in the gross light intensity. Likewise, Ba X-rays from Ba XRF source, and Tb X-rays from Tb XRF source present as Ba, and Tb salts respectively also showed the UV dominant optical emission [1]. Since both X-ray tube and XRF source emit basically X-rays, optical emission is expected even from X-ray tubes used in Hospitals for diagnostic purposes. As both X-ray and optical spectra can now be detected simultaneously, the data available opens up wide range of applications in future.


Two experimental discoveries in physics could be made from Variable Energy X-ray Source, AMC 2084 (U.K.) shown on the left. Along with X-rays, UV dominant optical emission emerging through the hole shown here was newly detected from (1) Rb, Ba, and Tb XRF sources present as salts, and (2) Cu, Ag, and Mo XRF sources present as metals.

## 4. DISCOVERY 3: UV DOMINANT OPTICAL EMISSION FROM METALS AT ROOM TEMPERATURE WHEN PRESENT AS RADIOISOTOPES OR XRF SOURCES

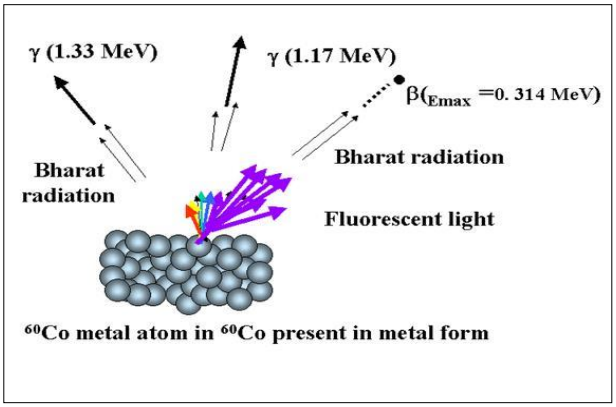
UV emission from metal sources remained elusive to previous researchers until the current study. Therefore, unprecedented detection of UV dominant optical emission from metals at room temperature could be a revolutionary experimental finding in the history of science. Optical emission was detected from cobalt metal when present as $^{57}$Co (AMC, U.K.); $^{60}$Co useful in cancer treatment; and also from Cu, Mo, and Ag metals present as Cu, Mo, and Ag XRF sources of AMC 2084,U.K. The optical radiation originating from metal sources hold vital key that it should be atomic emission of light from excited atoms in radioisotopes and XRF sources. Metal $^{57}$Co spectrum detected notably at room temperature pinpointed that the dominant γ-rays might be causing atomic emission spectrum from within the same excited $^{57}$Co atom by a previously unknown phenomenon that led to subatomic research.

The novel optical technique shown here (**a**) gives a glimpse how the photomultiplier tube (9635QB Thorn EMI) has simultaneously detected γ-rays, Fe X-rays and the successive and previously unknown UV, visible (VIS), and near infrared (NIR) radiation emissions from metal $^{57}$Co unprecedented at room temperature. Use of a pair of sheet polarizers helped in estimating the UV, VIS, and NIR radiation intensities in gross light intensity by subtracting counts between two successive steps [1]. Though metal is totally opaque to light, yet light emission that was detected has come from surface of the source. In order to explain these three experimental breakthroughs, previously unexplored area of sub-atomic research into excited atoms of radioisotopes and XRF sources led into a crop of three more fundamental physics discoveries.

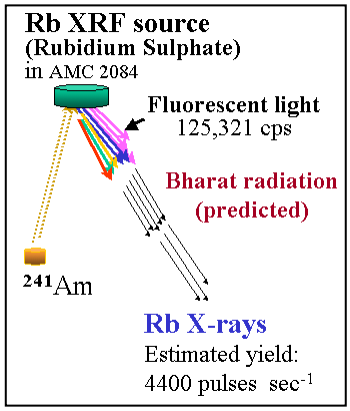



## 5. DISCOVERY 4: PREDICTED THE EXISTENCE OF BHARAT RADIATION

Ionizing radiation emissions causing fluorescent light emission from within an excited atom being new to nuclear physics, X-ray physics and atomic spectroscopy, the author has provided the most plausible explanation. In the first step towards this direction, a need arose to address the limitation that the ionizing radiations with keV or MeV energies known to knock out valence electron fail to do valence excitation to optical levels. The author has thus made an important postulate that within an excited atom the ionizing radiations first generate some exciting energy to be slightly higher than that of the observed UV at eV level, so that they do valence excitation resulting into UV emission.




Beta energy (0.314 MeV) within an excited $^{60}$Co atom in metal $^{60}$Co source first causes Bharat Radiation, which in turn causes UV dominant optical emission. Likewise, the two γ-energies 1.17 and 1.33 MeV also cause two more generations: Bharat radiation, followed by UV dominant optical emission.

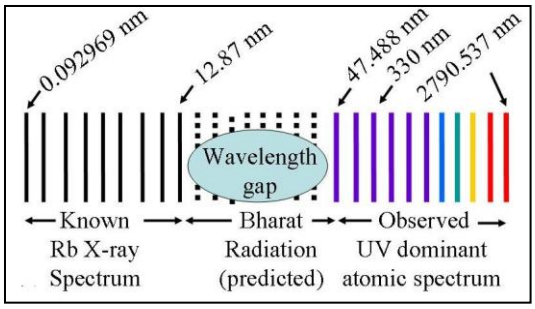



Of all the sources tested, Rb XRF source in AMC 2084, U.K. has shown spectacularly high counts. Just 4400 Rb X-ray pulses sec$^{-1}$ have caused Bharat Radiation, in turn caused 125,321 counts per sec due to UV dominant optical emission within excited Rb atoms. That means each X-ray has caused 28 light photons. Similarly, Ba X-rays caused these two emissions in Ba salt, and Cu X-rays did from metal Cu in AMC 2084,U.K.

### 5.1. Electromagnetic Spectrum redefined

It is well known that Rb salt emits Rb X-ray spectrum when irradiated with an intense gamma beam and emits the basic atomic spectrum when heated to high temperatures, as exemplified on the left and right sides of the figure below. When these two spectra are viewed together, a wavelength gap becomes evident in between the two. For the first time the author has shown existence of a wavelength gap from 12.87 to 47.488 nm in electromagnetic spectrum and also pinpointed the location of these predicted wavelengths in the gap.

### 5.2. Location of Bharat Radiation in E.M. Spectrum

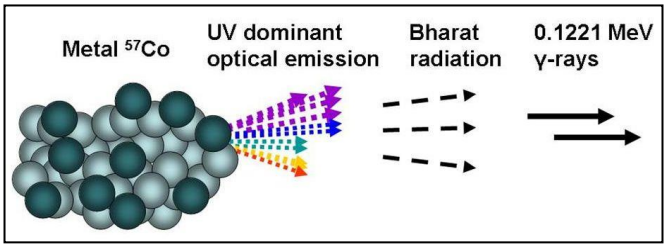



In the case of Rb XRF source, the location of wavelengths from 12.87 to 47.488 nm generated by Rb X-rays was predicted to be next to Rb X-ray wavelength range. And EUV and UV dominant optical wavelengths to be immediately next to the 12.87 to 47.488 nm range in electromagnetic spectrum. These wavelengths existing in between X-ray and optical spectra of electromagnetic spectrum and do not belong to either X-rays or light cannot be called either as X-rays or light, say from Rb XRF source. That is why these wavelengths were termed as "Bharat Radiation", for convenience. The schematic diagram shown here is the latest Rb XRF spectrum with two new emissions, Bharat and optical wavelengths lying side by side. Bharat Radiation wavelengths produced by γ or β from a radioisotope also would be situated within the same 12.87 to 47.488 nm. That means the latest γ or β spectrum includes two new emissions Bharat and optical wavelengths lying side by side. Though it was not possible to detect Bharat Radiation with photomultiplier tube, the author has recently discovered Bharat Radiation wavelengths from12.87 to 31 nm in solar spectra measured by various researchers since 1960s [12].

## 6. DISCOVERY 5: A NEW CLASS OF 'ROOM TEMPERATURE ATOMIC SPECTRA OF SOLID RADIOISOTOPES AND XRF SOURCES' CAUSED BY BHARAT RADIATION

So far only one kind of atomic spectra is known in literature that can be caused by thermal excitation. However, the current study has unveiled a new class of atomic spectra in the field of atomic spectroscopy exclusively from radioisotopes and XRF sources, since valence excitation takes place by Bharat Radiation energy higher than thermal energy produced by γ, β or X-ray energy within the same excited atom. For these reasons, UV dominant atomic spectra of ionizing radiation sources widely differed from basic atomic spectra. In these spectra UV would always be over 83% in the gross light intensity, while VIS and NIR radiation intensities share the remaining 17%. Low γ, β or X-ray energy from sources such as Rb XRF source, $^{113}$Sn, and $^{133}$Ba could emit UV with intensity above 95%, while the VIS and NIR radiations shared the rest 5%. Comparatively, high β energy from $^{90}$Ycould hardly cause 83.36% UV intensity, while VIS and NIR intensities correspondingly rose to 8.02% and 8.62%. Difference in nature of spectrum is evident between Rb XRF source and $^{86}$Rb, and between $^{57}$Co and $^{60}$Co [1]. This is due to the fact that the nature of atomic spectrum of any source depends purely upon its ionizing radiation energy regardless of atomic number Z, the type of radiation whether γ, β or X-ray, and nature of source medium whether salt or metal. These spectra can be produced not only from radioisotopes, but also from salts or metals on bombarding with intense gamma beam from source such as $^{241}$Am, as happens with AMC 2084, U.K. Bharat and optical emissions now available, besides X-rays from a XRF source, and besides γ, and β emissions from a radioisotope open up new frontiers for research and wide range of applications. Futuristic studies on the nature of atomic spectra of radioisotopes and XRF sources provide a new understanding on the energy levels of excited atom.

### 6.1. New 'atomic state of solids'




Metal $^{57}$Co source emits UV intensity as high as 88.18% notably at room temperature. Since excited $^{57}$Co atoms acted like free atoms, though surrounded by stable Co atoms at ground state in metal $^{57}$Co source, 0.1221 MeV γ-rays caused Bharat Radiation in turn caused UV dominant optical emission from excited atoms shown in dark shade.

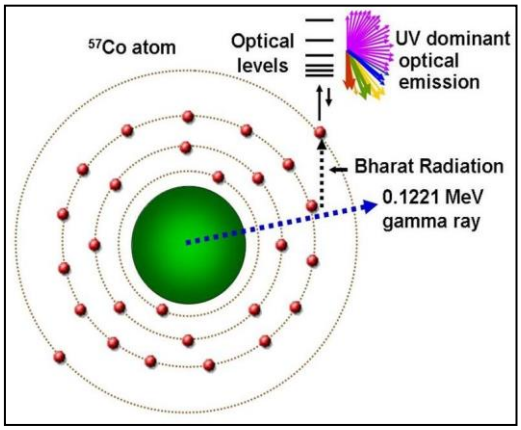
The question arises how solids can emit atomic spectra at room temperature. Valence excitation by Bharat radiation set the excited atoms free from surrounding unexcited atoms in ground state. As the excited atoms in radioisotopes and XRF sources remain temporarily as free atoms, the new 'atomic state of solids' that exists at room temperature itself is responsible for the typical spectra observed. Understandably, environment of excited atoms in solid radioisotopes and XRF sources that cause UV dominant optical spectra differs much from that of thermally excited atoms in gaseous phase causing the basic atomic spectra.

## 7. DISCOVERY 6: NEW ATOMIC PHENOMENON (PADMANABHA RAO EFFECT)

The previously unknown atomic phenomenon reportedly taking place in radioisotopes and XRF sources explains how γ, β or X-ray successively generates Bharat radiation (first generation), which in turn the UV dominant optical emission (second generation) within the same excited atom [1]. This phenomenon is known as Padmanabha Rao Effect [5-7].

The phenomenon takes place in two stages.

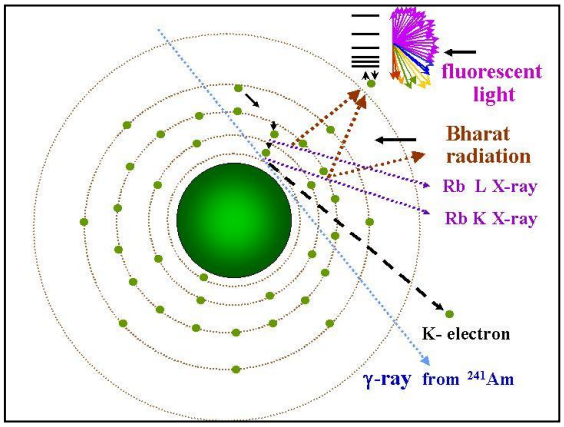
1. Ionizing radiation energy, particularly γ, β or X-ray energy at keV or MeV level loses energy just at eV level while passing through a core-Coulomb field. The loss of energy is reproduced as electromagnetic radiation (Bharat radiation) with the same energy at eV level but higher than that of UV or EUV that the source emits.
2. In turn, the Bharat energy generates UV dominant atomic spectrum on valence excitation.




The schematic diagram explains how 0.1221 MeV γ- ray in excited $^{57}$Co atom of metal $^{57}$Co source generates Bharat Radiation while passing through core Coulomb space, which in turn generates UV dominant optical emission on valence excitation by Padmanabha Rao Effect [1].

Core- Coulomb interaction of γ, β or X-ray is the notable feature in this atomic phenomenon. This phenomenon has certain distinct features that makes it entirely different from all other phenomena known in literature. In Photo electric effect, a gamma or X-ray directly hits a core electron and gives away all its energy to the electron so as to escape from the atom. In Compton Effect, gamma or X-ray goes little away from a core electron, and shares only part of its energy with the electron yet able to knock it out from the atom. As a result, both the scattered gamma or X-ray and the Compton electron escape from the atom. In the current phenomenon, γ, β or X-ray passes through core Coulomb space but more away from core electron than in the case of Compton Effect. As a result, γ, β or X-ray undergoes a very little loss of energy at eV level while passing through core Coulomb space, so that the core electron gets unaffected. As explained already, the loss of energy is released as an electromagnetic radiation termed Bharat Radiation, which in turn causes UV dominant optical emission on valence excitation. Therefore, γ, β or X-ray

with a very little loss of energy at eV level is successively followed by two more emissions namely the Bharat Radiation with eV energy and UV dominant optical radiation from one and the same excited atom. Two years were lasted in conceiving this phenomenon. This is how scientific discoveries take years of hard work, when the researcher remains uncertain how long it takes to resolve a puzzling issue.




UV dominant optical emission takes place from a salt such as Rubidium salt, when an incident γ or X-ray knocks away a K shell electron in Rb atom by photo electric effect. The resulting K X-ray, and L X-ray can generate Bharat Radiation photons while passing through Coulomb space of M shell electrons. Next, the Bharat Radiation photons generate UV dominant optical emission on valence excitation.

### 7.1. Tritium is a source of Bharat Radiation

The fact that $^{3}H$ (Tritium) did not show any optical emission validates the atomic phenomenon [1]. The reason being $^{3}H$ has only one electron, which is in K-shell. Passage of β-emission through K-shell Coulomb field generates a Bharat photon. It is to note that Padmanabha Rao Effect causes UV dominant optical emission from radioisotopes and XRF sources having at least two filled orbits. However, tritium has only filled orbit. In the absence of an electron in L-shell, the Bharat photon simply escapes from $^{3}H$ atom without producing any light photon by valence excitation. Unlike all other radioisotopes tested, $^{3}H$ proved to be an ideal source of Bharat radiation in the absence of any optical emission. Likewise, Bharat radiation emission alone takes place from highly ionized radionuclides left with a singly filled K shell that can happen in a situation like nuclear fission.

## 8. BHARAT RADIATION AND UV CAUSE SKIN DOSE TO HOSPITAL PATIENTS EXPOSED TO X-RAYS OR GAMMA RAYS

The current study suggests that the radiation dose data may need entry of UV as one more component, besides ionizing radiations in giving radiation dose to patients. Since Bharat Radiation and UV follow X-rays according to the current study, Bharat Radiation and UV from diagnostic X-ray tubes and CT scanners may subject the patients to higher skin dose than previously thought [10]. Bharat Radiation, UV emission following γ-rays from metal $^{60}Co$ may also contribute for the skin erythema noticed in cancer patients during $^{60}Co$ Teletherapy treatment [11]. By introducing a very thin Aluminum sheet or some other thick material between X-ray or gamma source and the patient helps in cutting off these radiations and thus the extra skin dose.

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