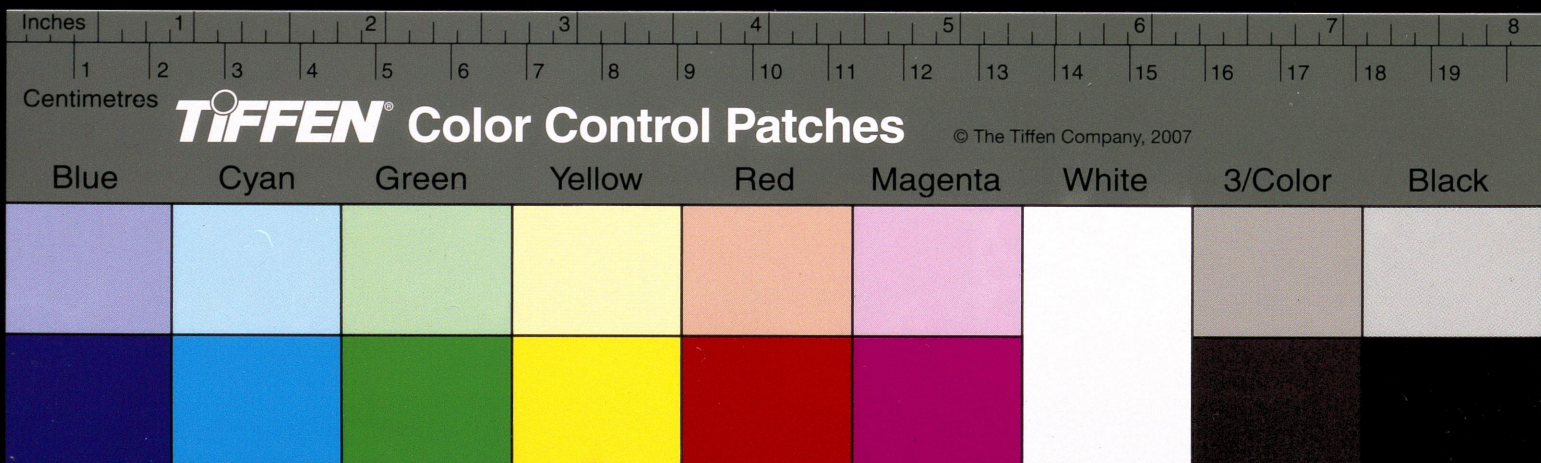


8 Little Falls Rd
Madhav Hill
Bombay
18 May 1940

My dear Madhava Rao,

Thank you very much for so
kindly sending me a report on Mukherji's Thesis.
I have had it typed, written a report on his first
paper, and added a summary of it. I have mentioned
in a covering note that the remarks on papers
2-6 are due to you and that I have complete
faith in your judgement. I think the thesis
will have been as fairly examined as is possible
in India. In my summary of it, I state that
the candidate's exposition is clear & concise, that
he does not show much originality, but that
may perhaps be due to environment. I end
by saying that if the candidate were enabled to
do research for some time ~~in~~ in contact
with an outstanding scientist in touch with the
newest developments in physics, then he might do



work of much value. I think that is perhaps a fair estimate of the case. The other thesis I examined certainly does not deserve the award of the studentship.

My appointment to Calcutta seems to have appeared in the papers, but I have not heard officially from the University yet! In any case, I shall not be going there till the end of July, and intend spending about a fortnight there. I hope to come to Bangalore at the beginning of June. Bombay is terribly hot & damp. I hope B'lore is more pleasant than when I left.

Things in Europe are beginning to look serious, but I still do not believe that the Allies will lose. I hope your reading is going well. As soon as I start writing my book, I shall have a number of problems requiring work. One of them might interest you. I am having a complete rest now.

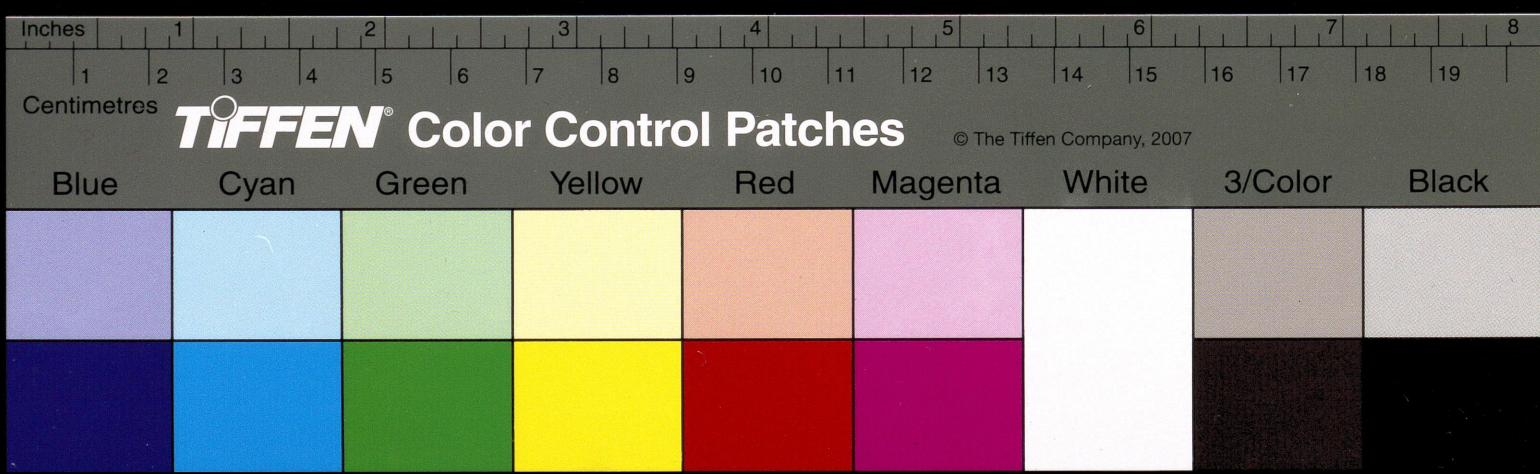
With kind regards

Yours sincerely

H. J. Prebber.

P.S. Will you kindly ask Mr C. V. Ramana if he has got the answers for my two papers which I sent week ago? I should also like 5 copies each of the reprints of both my papers sent to me at once. (I.e. without answers) (could you ask Mr. Ramana to do this?)

+ Could you kindly tell me of the number of the number in which the announcement occurred? I should like to see it.



A little Gibbs Rd.
Malabar Hill
Bombay
27 May 40.

12
Dear Madhava Rao,

I have just returned to
12th Venkataswami the corrected proofs of
my essay slips. Unfortunately they still
require a number of corrections. As they
will not have time to send me further
proofs, I have requested that they send
you the corrected proofs together with my
original typescripts of these essay slips.
I should be very grateful if you would
kindly do me the favour of correcting
the same for me. I am anxious that
no single misprint should occur in the

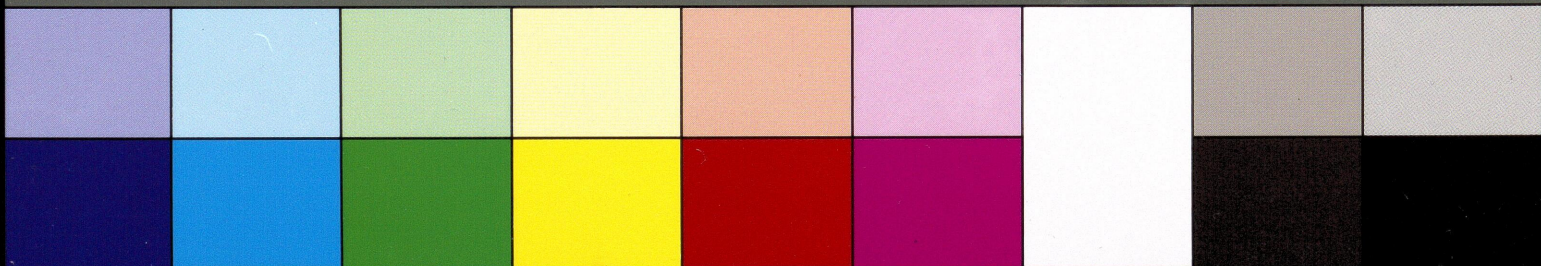
Inches 1 2 3 4 5 6 7 8

Centimetres 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19

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errata slips.

The hot and damp climate
of Bombay has got me down, & I have
broken out with a number of boils which
have troubled me the last few days.
However, they are now subsiding.

I hope your work is going well.
I have got a letter from Pauli about my
question as to the reduction of the Dirac
equation to the Hamilton-Jacobi eq: when a
 $\frac{1}{2} \hbar^2 \nabla^2 \psi$ term is present. He says he has
not done this himself, but the result ought
to be that of geometrical optics, giving
for example, two beams in a magnetic field.
I cannot see how this happens, but the problem
might be worth tackling seriously.

With kindest regards

Yr very sincerely
H. J. Bhabha

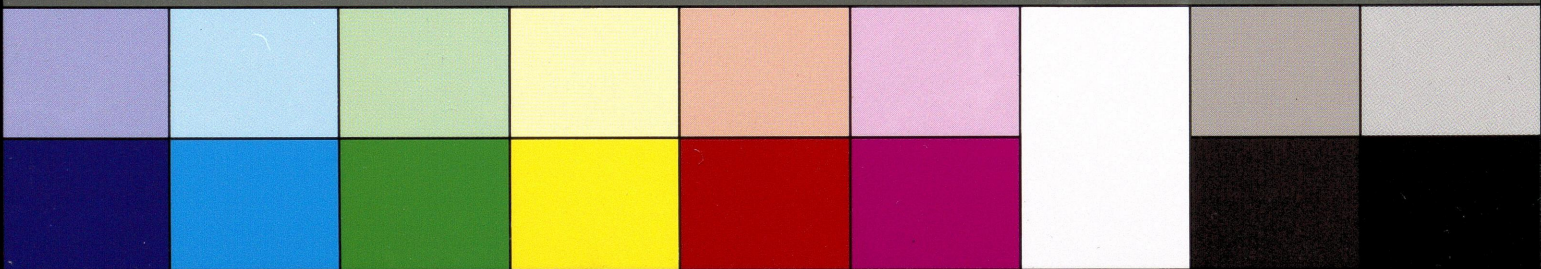
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Centimetres 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19

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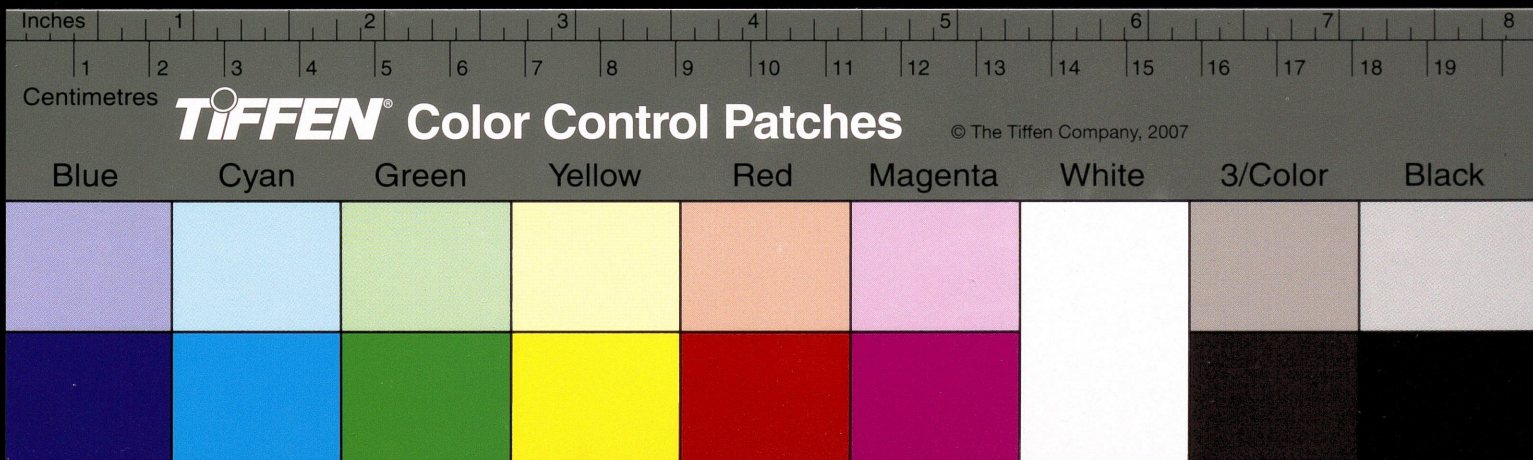
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L.S. I quote Paul "The result of the formalism must be similar to geometrical optics in the presence of a magnetic field (two different rays with different polarizations because of the Faraday effect -)." "

I shall be in Bangalore soon after the beginning of June.

I have been expecting to hear from Sir C. V. but have not done so. Is he away? Kindly give him my kindest regards



Great Eastern Hotel

Calcutta

2 Dec. 1940.

Dear Madhava Rao,

While in the train I thought of a slight mistake in our calculations. $\int \frac{4(\rho/m)(m/\rho/i)}{E_i - E_m}$ must be proportional to

$\frac{1}{V}$ not V as I put down. This is because

the wave functions of the heavy particles, which we have not given explicitly in the paper, have a normalising factor $\frac{1}{V}$. Thus, your original expression

with $\frac{1}{V}$ was right for $1/1$. As a result

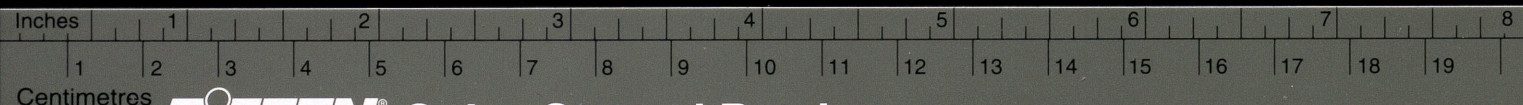
$$dQ = \dots V^2 / r^2 d\Omega$$

and not

$$dQ = \dots \frac{1}{V^2} / r^2 d\Omega$$

Please make these two corrections.

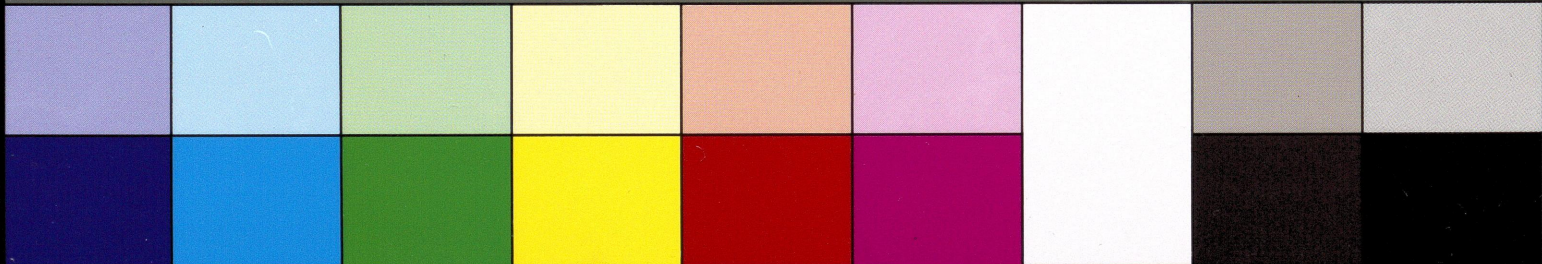
Thank you very much for coming to see me off. I thought Sir C. V. is conduct a bit strange at the end when he walked away. I felt he was offended about something - I don't know what. Please tell me frankly if he said



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any thing to you afterwards - I shall then try & rectify
the matter.

Do I try & get it published
in the Dec. number of the ~~Sci~~ Indian Head.
And there must be no misprints - the time -
not even in the language.

I thank you for your cooperation. I
hope to see you within a couple of months.
With best wishes

H. P. B. Leitch

P.S. Please write to me at the Great Eastern
Hotel & mark your letters "to A. W. B. Leitch"
till the 2nd.

Inches 1 2 3 4 5 6 7 8

Centimetres

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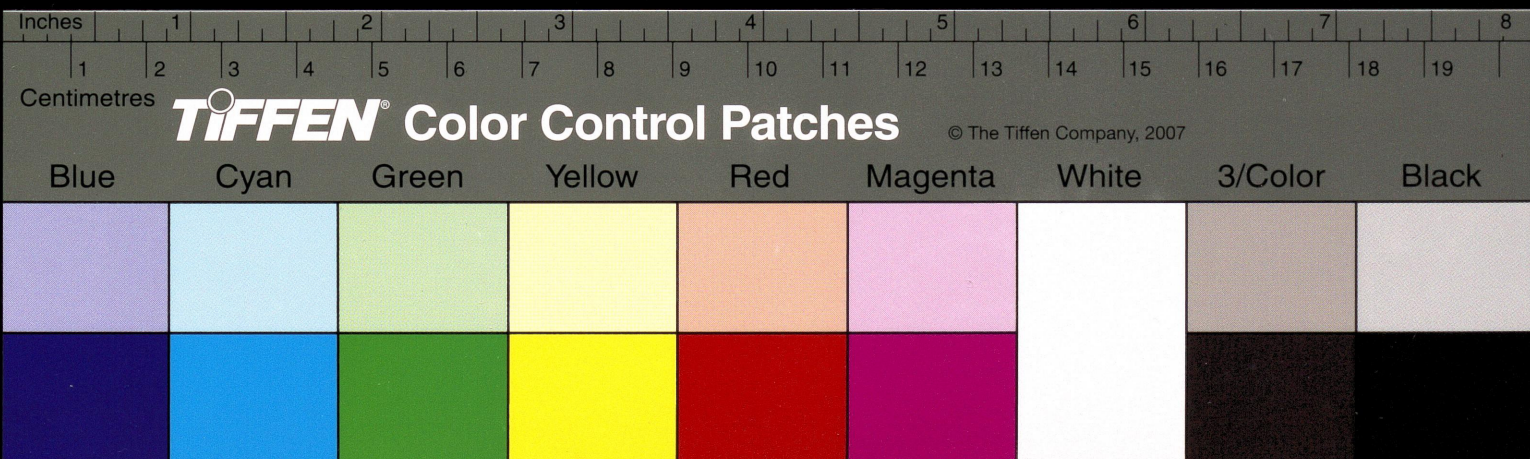
CALCUTTA 14. Dec. 1940

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My dear Bhabha Rao,

Thank you for the manuscript of
our paper + the meson manuscript, as also the
Phys. Rev. letter. I find there are some mistakes
in the paper + I hasten to inform you of them.
I also think that it is bad policy to have $c=1$
in part of the paper + $c \neq 1$ in the rest: It is
not even as if the $c=1$ consistently in the
whole of the classical section: In the corrections

I give below, I have therefore added the
appropriate powers of c .
p. 2. line 12 add "(cf. Heitler 1940)" after "classical theory".
p. 3 line 12, insert "constant" before
numerical.
p. 3 line 18 let this read "for a Maxwell field by Bhabha (1940)
and Bhabha + Cohen^{*}, and for a meson field by
Bhabha^{*} (1940c)".
p. 6. third line after (57). "intermediate" instead of "final" to
read "of the initial + intermediate states of the whole system."



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2 CALCUTTA 19

TELEGRAMS
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eg. 10. insert $d \sin$ at end.
p. 11, second line before (20), substitute "each of" for "all"
to read "cross-section for each of the four ..."
p. 12. line 1, read "Bhabha in a recent paper (1940c)."
p. 12. line 10, insert c before ω_0 , thus "in a wave
of frequency $c\omega_0$ with ..."

eg (21). " $\cos c\omega_0 t$ "

eg (22).
$$\frac{H_0^2}{8\pi} \frac{c\omega_0}{(\omega_0^2 - k^2)^{3/2}}$$

eg (23) $\sin c\omega_0 t$

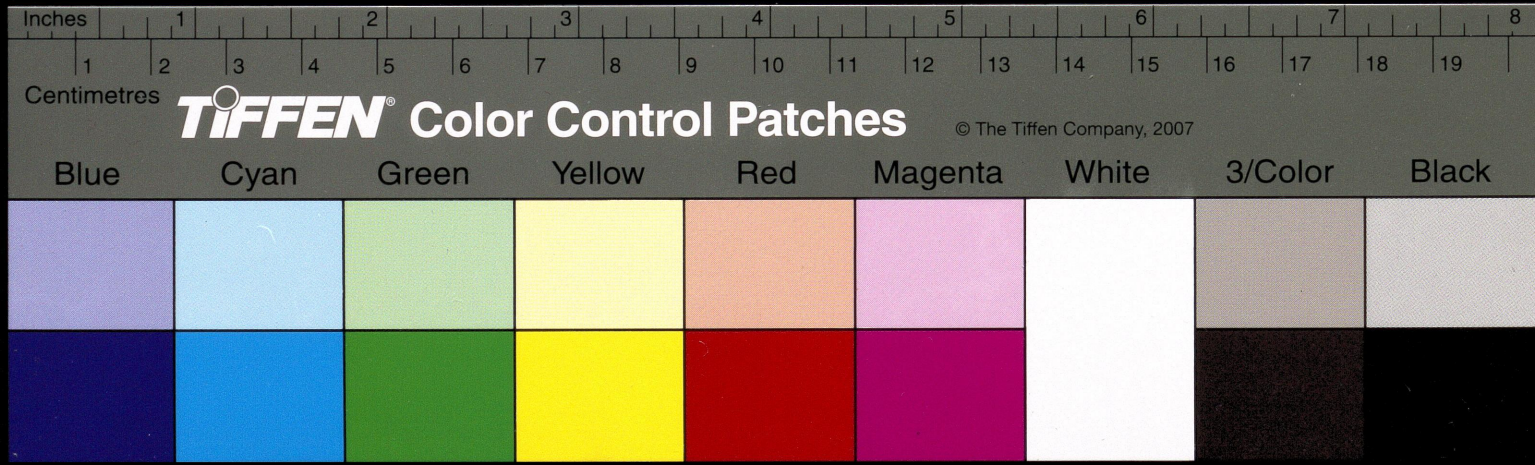
eg (24)
$$|M_1| = \frac{g_2 H_0 \sin \phi}{I c \omega_0}$$

p. 13 line third line after (24), substitute "by (23) are" instead
of "by (22) are".

eg (25) change to " $\cos \{ c\omega_0 t - v \sqrt{\omega_0^2 - k^2} \}$ "

eg (27)
$$\frac{1}{8\pi} g_2^2 \frac{c\omega_0 (\omega_0^2 - k^2)^{3/2}}{v^4} [v * M_1]^2$$

eg (28) }
eg (30a) } ~~with $c^2 I^2$ instead of I^2~~
eg (30b) } insert c^2 in denominator, i.e. with
 $\frac{c^2 \omega_0^2}{I}$ in place of ω_0^2



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3

p. 16 line 10 read "This is just $\frac{r}{M_1} \sin^2 \psi_1$ "
eg (33c) should read

$$dQ' \left. \begin{array}{l} \end{array} \right\} = \frac{g_2^4}{4I^2} \frac{(\omega_0^2 - \kappa^2)^2}{c^2 \omega_0^2} \sin^2 \theta \sin^2 \psi_1 d\Omega$$

$$= \frac{g_2^4}{4I^2} \frac{(\omega_0^2 - \kappa^2)^2}{c^2 \omega_0^2} \cos^2 \psi_0 d\Omega$$

p. 17 line 1 substitute "(31)" for "(32)"
p. 17 line 2 "cos²ψ₀" instead of "sin²ψ₀"
eg (33b) substitute "c²ω₀²" for "ω₀²" in denominator

The next equation should read

$$(e.g. [x \times 14.7]) = \dots = \frac{r}{M_1} \cos \psi_1 \sin^2 \theta$$

The next equation

$$dQ' \left\{ \begin{array}{l} (11) \rightarrow (11') \end{array} \right\} = \frac{g_2^4}{4I^2} \frac{(\omega_0^2 - \kappa^2)^2}{c^2 \omega_0^2} \sin^2 \theta \sin^2 \psi_1 d\Omega$$

eg (34c) reads which, by (32) reduces to

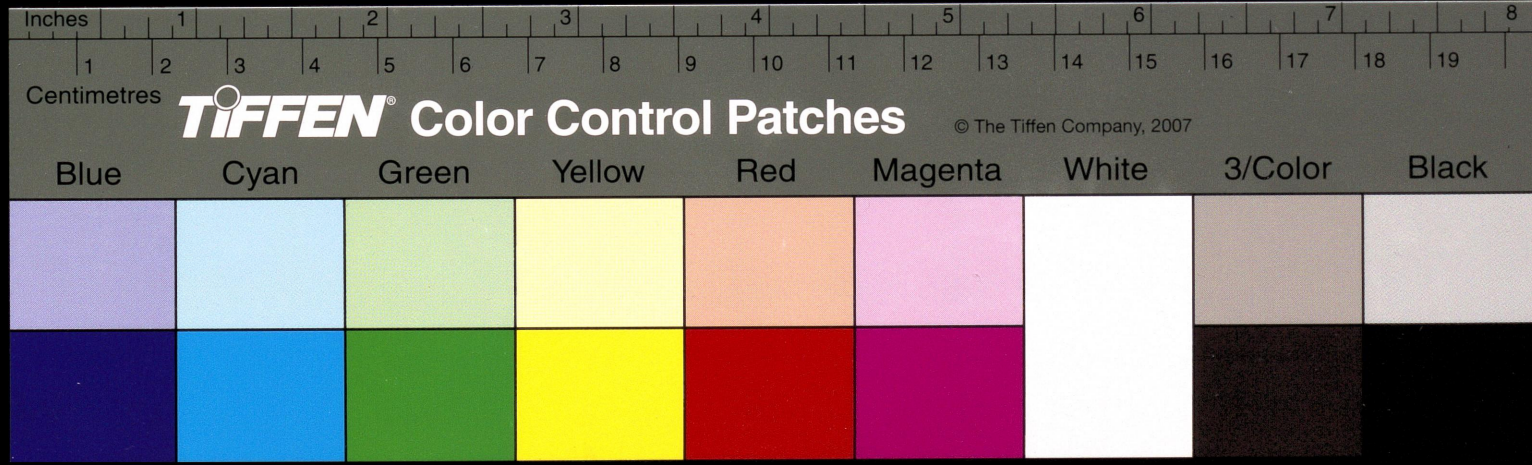
$$dQ' \left\{ \begin{array}{l} (11) \rightarrow (11') \end{array} \right\} = \frac{g_2^4}{4I^2} \frac{(\omega_0^2 - \kappa^2)^2}{c^2 \omega_0^2} \sin^2 \theta \cos^2 \psi_0 d\Omega$$

Two lines lower read "cos²ψ₀ by 1/3", instead of "sin²ψ₀ by 1/3"

eg (34b)
eg (35)
eg (36a) } substitute "c²ω₀²" for "ω₀²" in denominator

in next line (36b) read

$$\text{where } \alpha = 3Ic / 2g_2^2$$



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p 18 fourth line after (26c)

" $E = ct\omega_0$ " instead of " $E = \frac{1}{2}h\nu$ "

Eq (27) Write " $c^2\omega_0^2$ " for " ω_0^2 " in denominator

P.T.O.

p. 21 line 12 insert "the" before "quantum", to read
"between the quantum".

p. 21 line 20, change "would only seriously go wrong due to"
to "would only go wrong seriously due to".

p. 22 line 12. "on energy" instead of "of energy".

p. 22 line 21 "It shows ... " should not start

a new paragraph -
Insert "also", thus "It also shows that ..."

p. 23 line 1 read "by the factor $3(1 - 4\pi c^2/E)$ for ..."

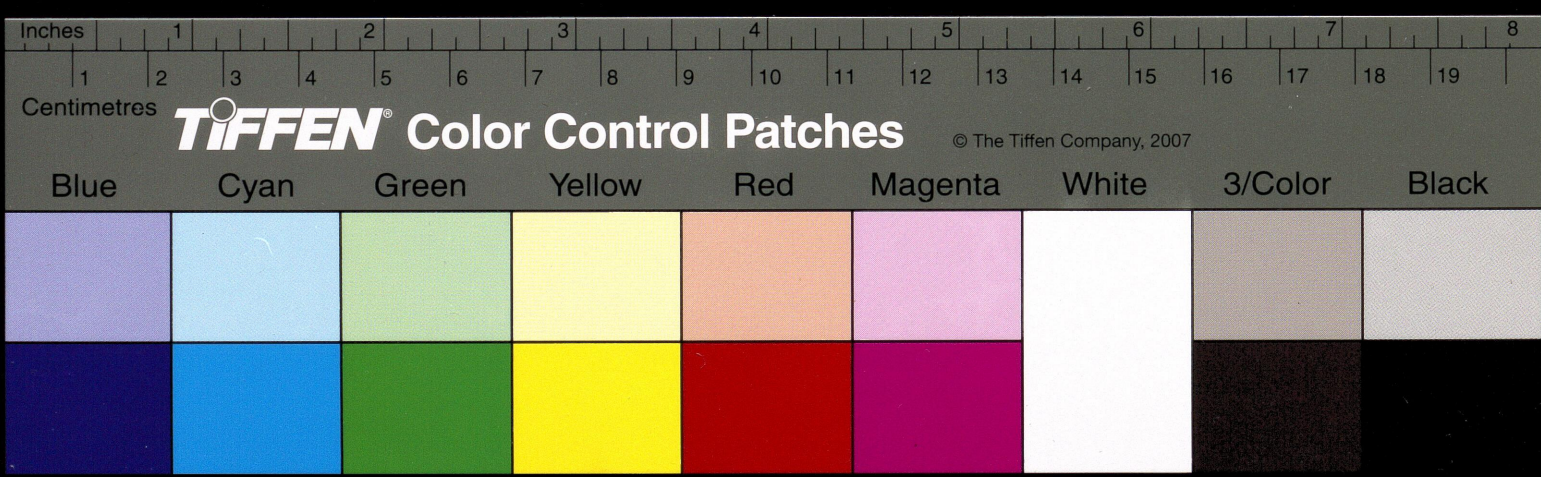
p. 24. line 9, substitute "Bhabha" instead of "one of us".

p. 24 line 16, transfer first sentence "Thus on this

assumption the scattering of charged mesons shows

complete correspondence with the classical theory, ...

in statics.



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Grand Telephone No. 252

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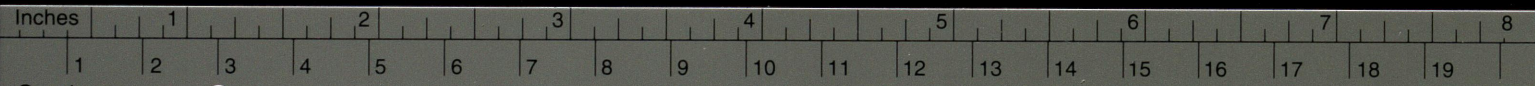
GENERAL MANAGERS
GREAT EASTERN HOTEL LTD.
CALCUTTA
INDIA

19 _____ CALCUTTA

Head of top of last column of Table

$$\left(\frac{4}{3} g_2'^4 h^4 / \mu^4 c^4 E^2 \right) d\Omega$$

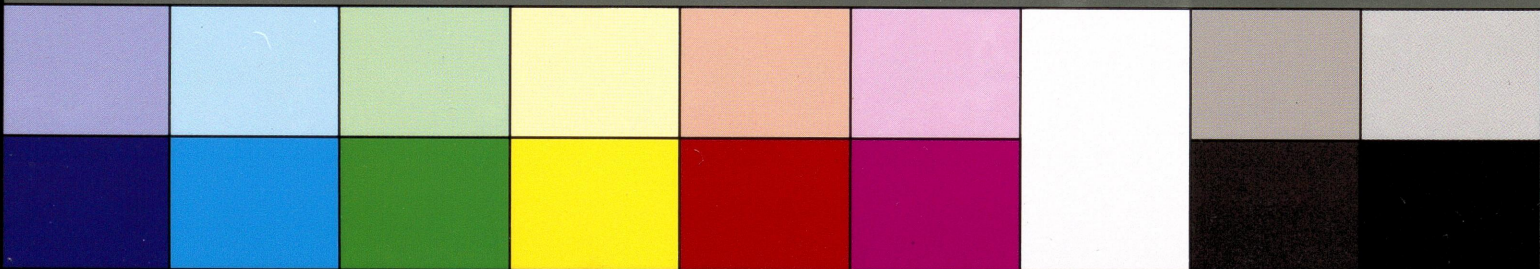
instead of $\left(\frac{4}{3} g_2'^4 h^4 / \mu^4 c^4 E^2 \right) d\Omega$



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5 CALCUTTA 19

Following the references, I think we should follow the Royal Society practice, which is slow what I did in my previous papers in the Academy, thus

- Bhabha 1938 Proc. Roy. Soc. A, 166, 501-25
- 1939 ibid 172, 354-408.
- 1940a Proc. Indian Acad. Sci. A, 11, 247-267, 467.
- 1940b ibid 11, 347-368, 468.
- 1940c Proc. Roy. Soc. A, in print.
- Heitler 1940 Nature 145, 29-30.

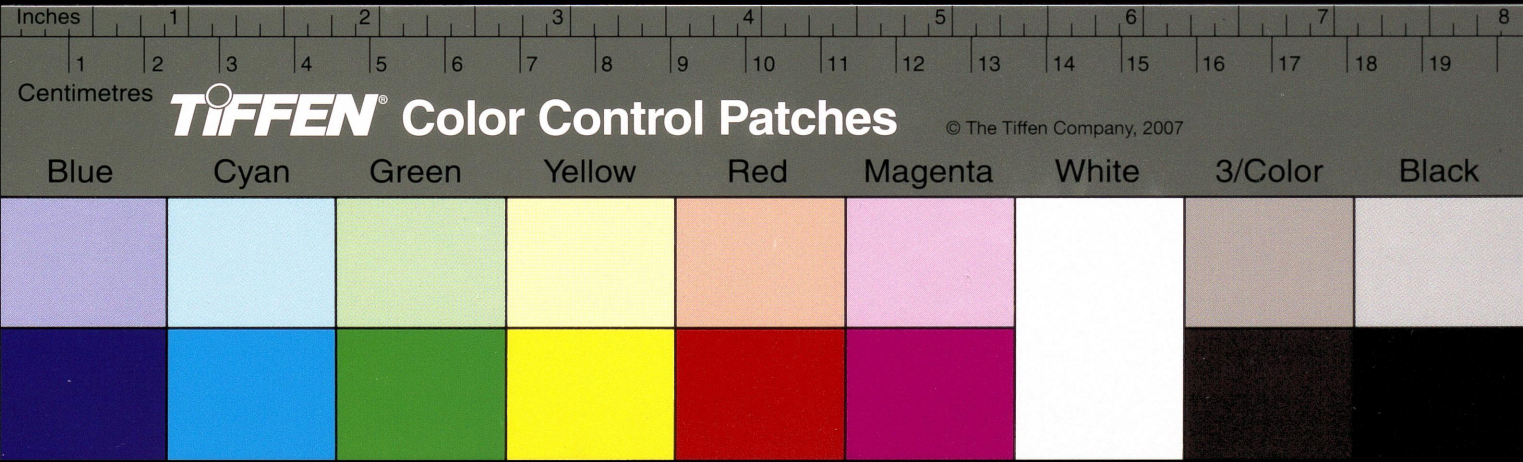
In figure I, the angle θ_0 should be marked as ϕ . Since in the text the axes are referred to as x, y, z , small letters should be used in both figures and not X, Y, Z .

I think this finishes all the errata. Please check the c factors. This you can easily do remembering that

$$g_2 = \text{charge} \times \text{length},$$

$$\omega_0 = 1/\text{length},$$

$$H = E = \sqrt{\text{energy/volume}}$$



19

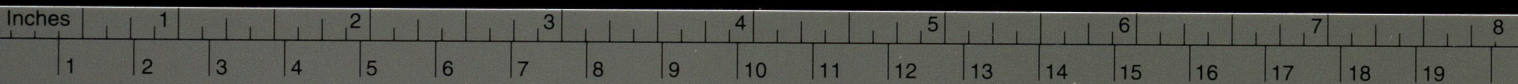
CALCUTTA

I am very keen that the printing of this
paper should be faultless. I do not mind
its appearing in the January issue instead of
the December issue. After all, there is no
urgent hurry. But under all circumstances
all the above corrections must be carefully
carried out & no new ones must appear.
You had better ask for 3 proofs.

I think the figures should be drawn
beautifully by the Institute artist. I am writing
to Sir C.V. to this effect. It will look
much nicer.

I hope you are having a nice time.
My own health has been rather bad. With
kind regards

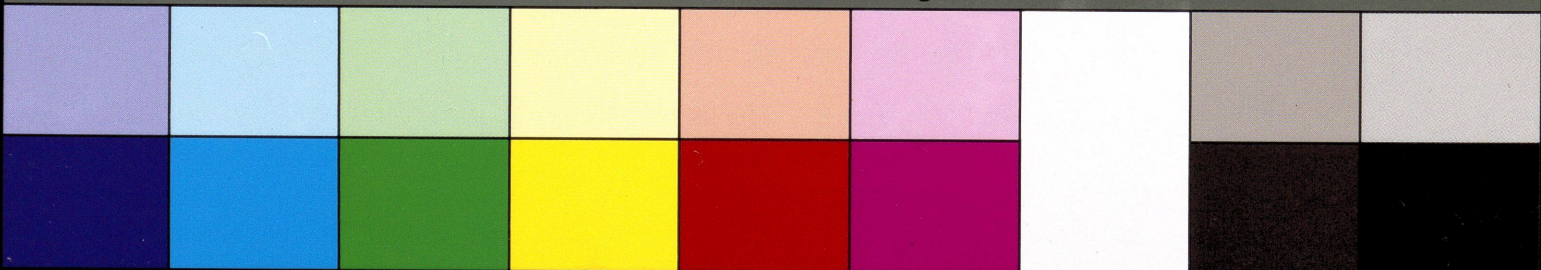
Yours sincerely
H. J. Bhabha



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A Little Gibbs Rd
Malabar Hill

Bombay

24 Jan. 41

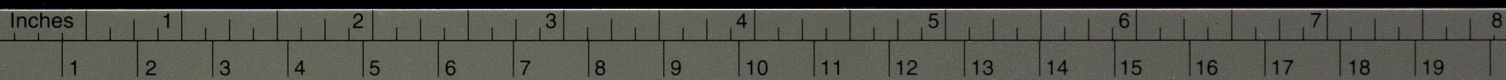
Dear Madhava Rao,

I am trying to catch today's
mail. I got your proof only yesterday when I
returned.

There are a number of corrections. Most
important are certain mistakes on p. 13, 14 & 15-
which I have corrected. I have added a paragraph
at the end of the paper & a line at the
end of the summary.

The alteration in (27) makes the later
references to this formula more intelligible.

There is one correction I have made in
pencil. In (5) you have $(f/l_0/m)(m/l_0/i)$
whereas on top of p. 5 you have $(i/l_0/m)(m/l_0/f)$.
Why this change? I think it should be corrected
there and below. Alternately each formula (5) read
 $(i/l_0/m)(m/l_0/f)$. I leave this to you to decide.
The other corrections must be made.



Centimetres

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Cyan

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Yellow

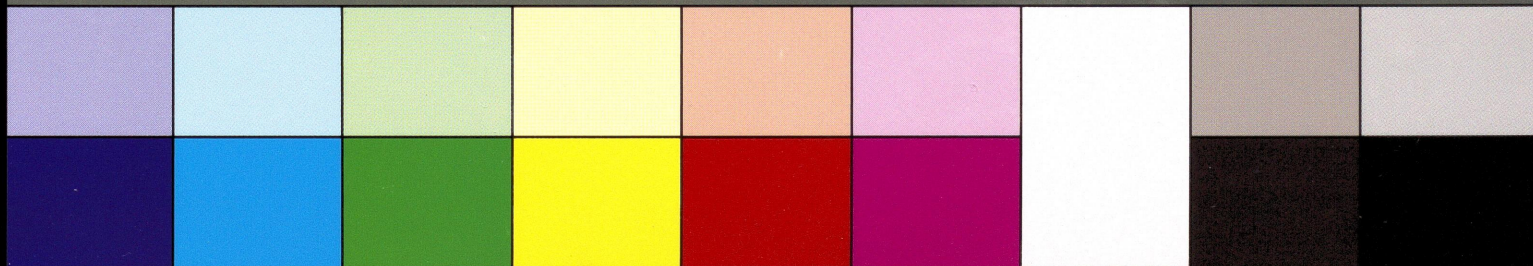
Red

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The letter in (4) is capital script I not θ
(Greek theta). I should like this changed, but
if they have no such letter, it may be left
as θ .

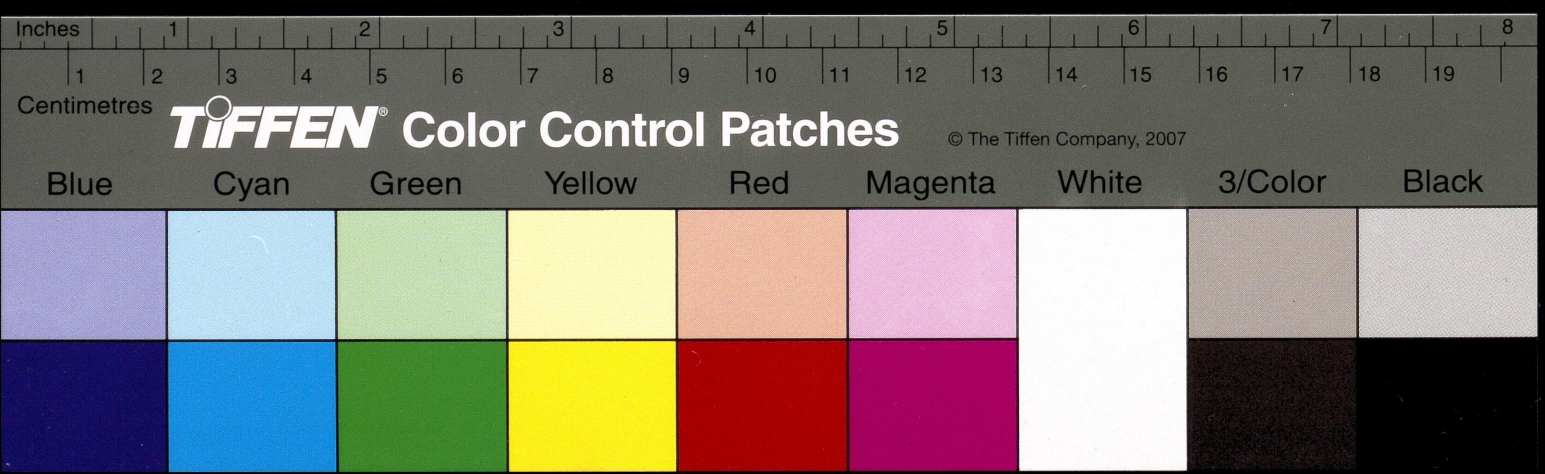
I hope it is not too late to get
the corrections through. Otherwise the paper must be delayed till Feb. as some of
them have to get another proof to make sure they
have committed no new mistakes in resetting.
I beset this to my cost when my last
Head. paper came out.

Please reply to this letter. I shall
be in B'lore on the 2nd Feb.

With great haste

H. J. Bhattacharya

The corrections are in hand



Bombay
24 Jan. 41.

Dear Madhava Rao,

I have just posted the corrected
proof of our paper to ^{registered} you. I forgot to mention
one point. The angles ϕ_0 , ϕ_0 , + θ_0 are
correct as they stand in the proof. I had
made a mistake when I wrote to you last
time.

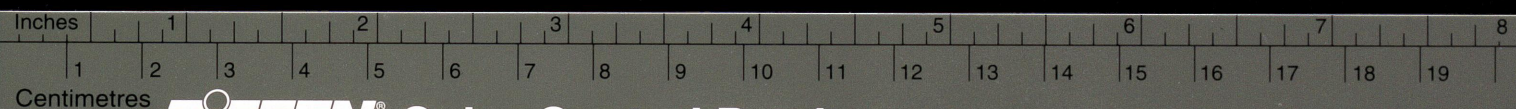
The point of ϵ , α , and σ will do, if
there is nothing better to be done about it.

I have got Paul's letter & will give it
to you when I return. I am not satisfied with
Paul's solution. You might tackle this problem
next. I shall only be satisfied when you get
out the equations for the rotation of the sphere,
namely

$$\frac{1}{2} \dot{\theta} \dot{\sigma} = g_2 [\dot{\sigma} - H]$$

out of the Dirac⁺ equations with a g_2 term. You
will notice that $\dot{\theta}$ does to appear explicitly in that
equation.

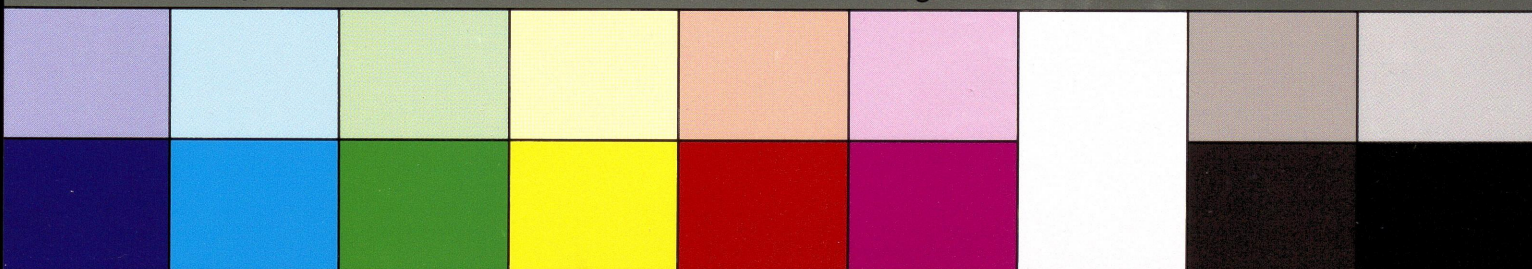
Please do not let the paper go through



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without the corrections I have sent - about the scattering of positive & negative mesons. What we had there is definitely wrong.

formed in both cases.

$$Y^+ + p \rightarrow \left\{ \begin{matrix} h_2 \\ Y^+ + \cancel{h_2} + Y^+ \end{matrix} \right\} \rightarrow Y^{+'} + p$$

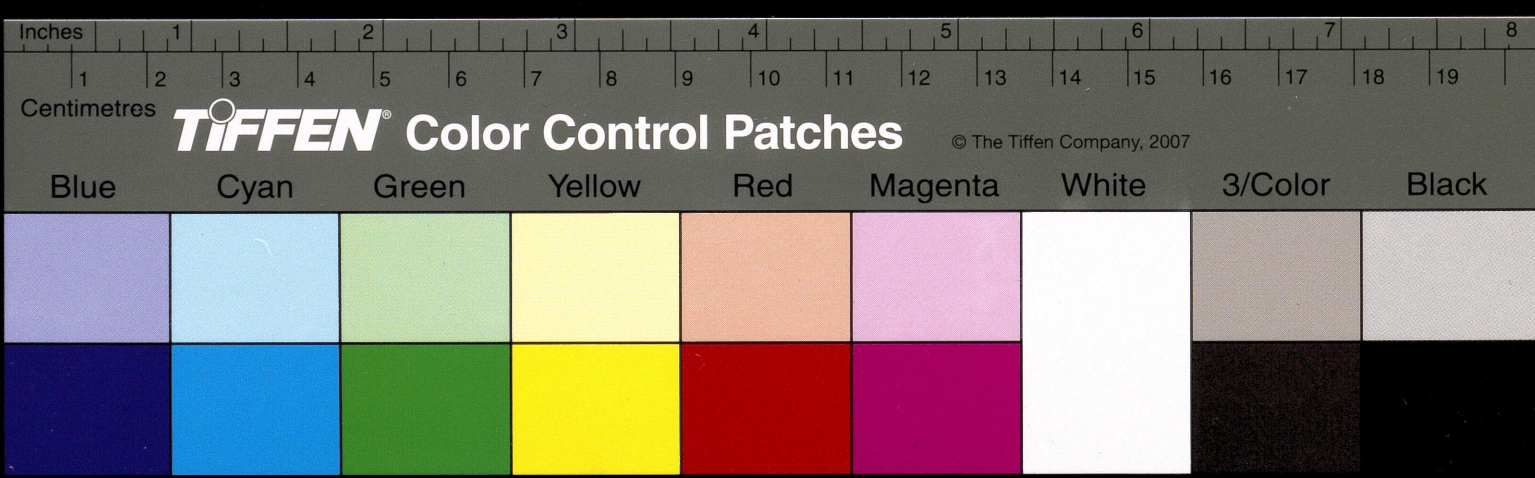
$$Y^{+-} + p \rightarrow \left\{ \begin{matrix} n \\ Y^- + h_2 + Y^- \end{matrix} \right\} \rightarrow Y^{-'} + p$$

The other case you can also verify.

Please also insert the para. about Heitler & Ma.

Yours sincerely

H. J. Bethe.

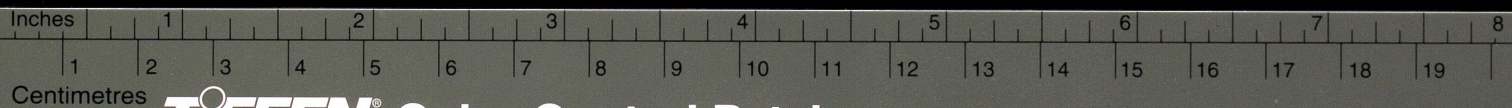


(1)

SI - Juns
Ootocamund
10 Nov 41

My dear Madhava Rao,

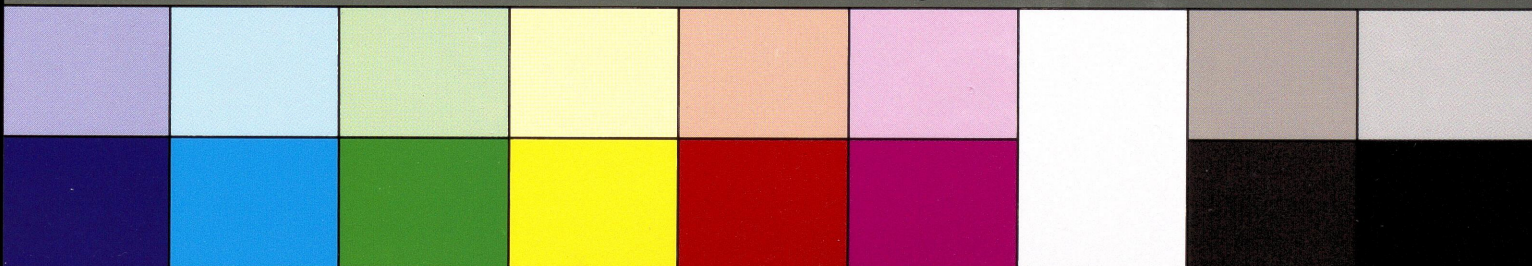
There is one very queer point -
which Bann & I have come across. It is
that d_{nd} order processes calculated on the
basis of the theory (a) that all the negative
energy states of the electron or other Dirac particle
(spin $1/2$) are empty is not the same as when
calculated on the assumption (b) that all the
negative energy states are full. (~~Dirac~~ ^{Dirac} - hole theory)
This result is so predominant that I can hardly
believe that all previous workers including myself
have made the same mistake. As I see it,
assumption (a) gives the Klein-Nishina formula,
(b) does not. To my knowledge there is only
one occasion on which the discrepancy has been
noticed, namely the calculation of the 2nd order self-



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energy of an electron by Weisskopf - which (a) &
(b) give different results. If I am right in
thinking that (a) & (b) give different results, then
it would be a very severe blow to "hole" theory.

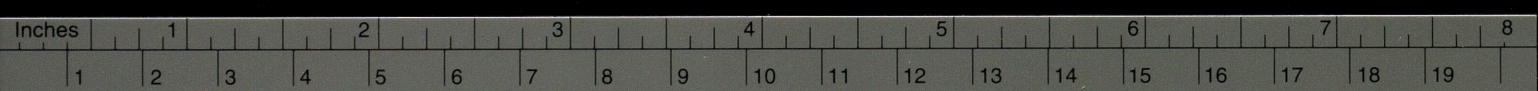
I would therefore like to have an independent
check on this point and would therefore be very
grateful if you would independently just compare
the difference in sign of one term between (a) &

(b). If you get into touch with ^{Dr.} Bain at
the Indian Institute of Science, he will explain
everything to you. I have written to him.

I shall be in Bombay by the 15th
& will see you a day or two after that.

With kind regards

Yr sincerely
H. J. Shebber.



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