6/4/82

DEAR KIRK

FROM NATHAN MYHRVOLD

I'M SORRY I HAVEN'T BEEN QUICKER ABOUT FINISHING UP THOSE CALCULATIONS, BUT I'M SUPPOSED TO FINISH UP MY PAPER IN TIME FOR MALCOLM'S RETURN (SOME TIME THIS WEEK OR NEXT). I'LL TRY HAVE SOMETHING MORE DETAILED THAN THIS NOTE FOR YOU BY MONDAY OR WEDNESDAY.

I'VE BEEN LOOKING INTO SEVERAL THINGS:

1. CIRCULAR MOTION

ALTHOUGH THE POWER STILL LOOKS TOO LOW IN THE PEAK RANGE OF THE SPECTRUM, THE TAIL (HIGH ENERGY) END OF THE SPECTRUM LOOKS PROMISING. IT IS MUCH FATTER THAN THAT FOR A THERMAL SPECTRUM AT THE SAME PEAK ENERGY. THE PAPER BY LOTAN & PFAUSTAVA WHICH YOU MENTIONED HAS GRAPHS OF THE SPECTRUM (LOOK AT THE "CONSTANT ACCELERATION" GRAPH). ALTHOUGH L & P BLEW IT ON THE REST OF THEIR PAPER, THEIR GRAPH IS O.K.

ANYWAY, THERE IS HOPE THAT AT SUFFICIENTLY HIGH ENERGY THE RADIATION FROM OUR PROCESS WILL BECOME COMPARABLE TO SYNCHROTRON RADIATION - I'LL WORK ON CHECKING THIS OUT MORE.

2. LINEAR MOTION - I'M GOING TO WRITE UP A LITTLE CALCULATION TO SEE WHAT WE CAN EXPECT FROM THIS CASE.

3. Quantum Mechanical Approach

Your question about the fully quantum mechanical approach to the "acceleration radiation" is both interesting and difficult, for quite some time I've been planning to work out a Q.M. version of this stuff, but I haven't found the time. I'll try do some preliminary work this ~~week~~ week. ~~etc.~~

Nathan

KIRK:

6/23/92

THE CORRECT ACCELERATION a TO USE IN $T = \frac{\hbar a}{2\pi kc}$ DOES SEEM TO BE THE ACCELERATION AS MEASURED IN THE REST FRAME OF THE ACCELERATING OBJECT. IF THE ACCELERATION IS COLINEAR WITH THE VELOCITY THEN IT IS RELATED TO THE LAB ACC. BY γ^3 AS YOU SAID. THERE ARE A FEW CAVEATS HOWEVER — SINCE THE TEMPERATURE AND INTENSITY OF THE "RADIATION" YOU GET FROM $T = \frac{\hbar}{2\pi kc} a$ IS IN THE REST FRAME OF THE OBJECT, IT MUST THEREFORE ~~AT LEAST THIS MUST~~ BE COMPARED TO OTHER INCOMING STUFF WHICH IS BLUE SHIFTED BY A FACTOR γ.

I'D LIKE TO TALK TO TALK TO YOU ABOUT THIS SOME TIME SOON. I'M USUALLY IN IN THE MID TO LATE AFTERNOONS (1:30 TO 5:00) (SOME TIMES I'M IN THE STUDENT SHOP WORKING ON MY CANNON), I ALSO AM THERE LATE AT NIGHT (9 PM TO 4 OR 6 AM). DROP A NOTE IN MY BOX IF YOU WANT TO ARRANGE SOMETHING — I AM WILLING TO COME IN MORNINGS IF IT'S REALLY NECESSARY.

I MADE COPIES OF THE TWO SCIAMA PREPRINTS FOR YOU. ALTHOUGH SOME OF THE TREATMENT ~~IS~~ ISN'T VERY RELEVANT UNLESS YOU'RE USED TO A PARTICULAR SET OF JARGON (SUCH AS QUANTUM OPTICS) — THEY DO GIVE A GOOD INTRODUCTION

TO the SUBJECT.

DEAR KIRK

HERE IS THE FIRST INSTALLMENT OF MY CALCULATIONS. UNFORTUNATELY I HAD SEVERE XEROX MACHINE PROBLEMS SO THIS IS ONLY PART OF WHAT I HAVE.

I THOUGHT IT WOULD BE USEFUL TO WRITE DOWN A ~~FEW~~ BASIC SUMMARY OF THE THEORETICAL APPROACHES + REFERENCES. I HAVE ALSO INCLUDED SOME OF MY SPECULATIONS ON ~~HOW I PLAN TO GO~~ THE WAYS TO DISTINGUISH THE THERMAL RADIATION FROM THE SYNCHROTRON OR BREMSSTRAHLUNG BACKGROUND. I'LL HAVE MY NUMERICAL ESTIMATES FOR YOU SOON.

I'VE FOUND A PRETTY GOOD BOOK ON SYNCHROTRON RADIATION:

SYNCHROTRON RADIATION BY SOKOLOV AND TERNOV 82/6. 655 .1968.

THE LIBRARY HAS SEVERAL COPIES IF YOU WANT TO LOOK AT ONE.

Princeton University DEPARTMENT OF PHYSICS: JOSEPH HENRY LABORATORIES
JADWIN HALL
POST OFFICE BOX 708
PRINCETON, NEW JERSEY 08544

July 8, 1983

Prof. J. Schwinger
Dept. of Physics
U.C.L.A.
Los Angeles, CA 90024

Dear Prof. Schwinger,

Some recent results of general relativity have caused renewed interest in your work of the early 50's on electrons in strong electromagnetic field. The new issues are intriguing but rather technical and I would appreciate any advice you would care to give.

The basic idea of Fulling, Davies, and Unruh is that the Hawking radiation effect from black holes has an equivalent effect for accelerated observers in zero gravitational field. Further, a charged, accelerating observer such as an electron can scatter off the thermal bath of radiation leading to light detectable by an inertial observer. Of course this 'scattering' process as viewed by an inertial observer could also be considered as a correction to more ordinary forms of radiation of an accelerating charge. A semiclassical model uses the Hawking temperature

$$T = \frac{\hbar a}{2\pi c k} \qquad \text{(a = rest frame acceleration)}$$

to suggest an electron would radiate an additional power of

$$\frac{dU}{dt} = \frac{\hbar r_0^2 a^4}{90\pi c^6} \qquad \left(r_0 = e^2/mc^2\right)$$

The dependence of the radiation rate on the fourth power of the acceleration is indicative of an underlying thermal process.

For the new effect to be sizable the acceleration must be very large indeed, $>10^{31}$ g . Aside from elementary particle collisions in which the concept of acceleration is doubtful, such large accelerations might be achieved in 'collisions' of the SLAC electron beam with a very high intensity laser beam.

A recent thesis by Nathan Myhrvold at Princeton examines the propagation of an electron in a strong static electric field and concludes the thermal radiation effect is indeed present, based on your earlier work. However the study was not carried far enough to indicate how the thermal effects might be clearly distinguished from other QED processes.

Any comment or advice you would care to give on this matter would be most welcome.

Sincerely yours,

Kirk McDonald
Assoc. Prof. of Physics

From: SMTP%"unruh@physics.ubc.ca" 23-APR-1998 13:24:24.03
To: "Kirk T. McDonald 609-258-6608" <mcdonald@puphed.princeton.edu>
CC:
Subj: Re: My paper

Return-Path: unruh@physics.ubc.ca
Received: by puphed.princeton.edu (UCX V4.1-12, OpenVMS V7.0 VAX);
Thu, 23 Apr 1998 13:24:22 -0400
Received: from theory.physics.ubc.ca (black-hole.physics.ubc.ca [137.82.43.40])
by feynman.princeton.edu (8.8.8/8.8.8) with ESMTP id NAA26069
for <mcdonald@puphed.princeton.edu>; Thu, 23 Apr 1998 13:24:23 -0400 (EDT)
Received: from localhost (unruh@localhost) by theory.physics.ubc.ca (8.8.5/8.8.3) with SMTP id KAA02779 for <mcdonald@puphed.princeton.edu>; Thu, 23 Apr 1998 10:24:22 -0700 (PDT)
X-Authentication-Warning: black-hole: unruh owned process doing -bs
Date: Thu, 23 Apr 1998 10:24:22 -0700 (PDT)
From: Bill Unruh <unruh@physics.ubc.ca>
X-Sender: unruh@black_hole
To: "Kirk T. McDonald 609-258-6608" <mcdonald@puphed.princeton.edu>
Subject: Re: My paper
In-Reply-To: <98042312565836@puphed.princeton.edu>
Message-ID: <Pine.SUN.3.95.980423101835.2775A-100000@black_hole>
MIME-Version: 1.0
Content-Type: TEXT/PLAIN; charset=US-ASCII

Yes, it turned out to be somewhat more complicated than I expected!. On the other hand I at least feeel that it gives a much better physical insight into what is happening than does the classical approach. In particular, I have had a long arguement with Jackson as to whether or not the classical approach requires that the particle move in the z direction-- Jackson claiming that it does not. (Bell and Leinaas and my approach make clear that that z motion is absolutely essential for explaining the depolarisation details) I guess that is my main problem with the classical approach- it is simply a calculation which produces almost no insight into what is going on, at least for me (Me? Biased?).

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On Thu, 23 Apr 1998, Kirk T. McDonald 609-258-6608 wrote:

> Received: from physics.ubc.ca (physics.ubc.ca [137.82.43.9]) by theory.physics.ubc.ca (8.8.5/8.8.3) with ESMTP id JAA02734 for <unruh@black-hole.physics.ubc.ca>; Thu, 23 Apr 1998 09:59:26 -0700 (PDT)
> Received: from feynman.princeton.edu (root@feynman.Princeton.EDU [128.112.100.5])
> by physics.ubc.ca (8.8.5/8.8.5) with ESMTP id JAA25676
> for <unruh@physics.ubc.ca>; Thu, 23 Apr 1998 09:59:17 -0700 (PDT)
> Received: from PUPHED (puphed.hep.princeton.edu [128.112.100.25])
> by feynman.princeton.edu (8.8.8/8.8.8) with SMTP id MAA23968
> for <unruh@physics.ubc.ca>; Thu, 23 Apr 1998 12:59:14 -0400 (EDT)
> Date: Thu, 23 Apr 1998 12:56:58 -0400
> Message-ID: <98042312565836@puphed.princeton.edu>
> From: "Kirk T. McDonald 609-258-6608" <mcdonald@puphed.princeton.edu>

> To: unruh@physics.ubc.ca
> Subject: Re: My paper
> X-VMS-To: SMTP%"unruh@physics.ubc.ca"
>
> Bill,
>
> I did pick your paper off the Web and have read it with interest --
> tho without mastery of the details.
>
> It looks good! But one might be pressed to say that it's simpler than
> the `classic' approach.
>
> Since the Debate with Jackson was about the validity of the approach, not
> the complexity, I'd say the Hawking-Unruh view is holding its own....
>
> --Kirk
>

From: SMTP%"finnr@fermi.phys.washington.edu" 5-MAR-1999 14:07:55.85
To: "Kirk T. McDonald 609-258-6608" <mcdonald@puphed.princeton.edu>
CC:
Subj: Re: strong fields

Kirk:

My Klein's Paradox paper is hidden away in Physica Scripta 23, 1030 (1981). A similar paper by Barry Holstein can be found in Am.J.Phys. 66, 507 (1998). The Leinaas of the Bell-Leinaas paper on the Unruh effect for circularly accelerated particles is a colleague of mine in Oslo.

I've looked at the papers in your accel subdirectory. Which one in particular is the version you wrote for Am.J.Phys. and where you had problems with the referees?

Finn R.

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