Dear Kirk

From Nathan Myhrvold

I'm sorry I haven't been quick
about finishing up those calculations, but
I'm supposed to finish up your paper in

time for Malcolm's return (some time next
week or next). I'll try to 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 power of the spectrum,
the tail (high energy) end of the
spectrum looks promising; it is
much faster than that for a thermal
spectrum at the same peak energy.
The paper by Kunitoh and Pavasara
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 this process will become capable
of synchrotron radiation - I'll work
on checking this out more.

2. Linear motion - I'm going to write
up a little calculation to see if what
we can expect from this case.
3. Quantum Mechanical Approach

Your question about the full quantum mechanical approach to the "acceleration radiation" is both interesting and difficult. For quite some time I've been trying to work out a Q.M. version of this stuff, but I haven't found the time. I'll try to do some preliminary work this week.
The correct acceleration a to use in $T = \frac{v}{a}$ does seem to be
the acceleration as measured in the
rest frame of the accelerating
object. If the acceleration is
collinear with the velocity then it
is relative to the LAB acc. by dy
as you said.

Think about a few comments
However, since the temperature and intensity
of the "radiation" you get from
$T = \frac{v}{a}$

is in the rest frame of the object,
it must therefore
be compared to other
incoming stuff which is blue shifted
by a factor $\gamma$.

I'd like to talk to you about this soon.
I'm usually in the lab in the afternoons
(sometimes I'm in the student shop
working on my cannon), 1 AM
and 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 is really
necessary.

I made copies of the two
scanned presentations for you. Although
some of the treatment isn't very
relevant unless you're used to a
particular set of Jackson (such as quantum
optics) - they do give a good introduction
to Mr. SUBRINER.

[Signature]
DEAR KIRK

Here's 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 basic summary of my theoretical approaches and references. I have also included some of my speculations on how the ways to distinguish the thermal radiation from 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 82/9, 655 1968.

The library has several copies if you want to look at one.
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

$$T = \frac{k \alpha}{2 \pi c^2}$$

(a = rest frame acceleration)

to suggest an electron would radiate an additional power of

$$\frac{dU}{dt} = \frac{4 \pi \alpha q}{\varphi_0 \sqrt{\alpha}} \left( \frac{\varphi_0}{\varphi_0 + \alpha c^2} \right)$$

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, \(>10^{-8} \text{g}\). 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
Yes, it turned out to be somewhat more complicated than I expected!. On
the other hand I at least feel 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?).

William G. Unruh  Canadian Institute for  Tel: +1(604)822-3273
Physics&Astronomy  Advanced Research  Fax: +1(604)822-5324
UBC, Vancouver,BC  Program in Cosmology  unruh@physics.ubc.ca
Canada V6T 1Z1       and Gravity  http://axion.physics.ubc.ca/

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
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> Received: from PUPHED (puphed.hep.princeton.edu [128.112.100.25])
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> 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>
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
Kirk:


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.