

reference

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Chapter 1

reference

1.1 reference

Fields - DOCUMENTATION.
Version 1.0, September 1,1996.

The program Fields is copyright 1996 by T. Baumeister.
It is freely distributable as long as this documentation
is included.

Contents:

=====

Introduction	
How to use	Tutorial
The Theorie	for all those who like physics ;-) Come on click it!
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1.2 Fields Documentation: Introductiuon

NO INTRODUCTION YET.

This program was one week of extreme programming %-|

CHILDRENS ARE ADVICED NOT TO IMITATE IT AT HOME!

I think this programm has cost me 5 kilos
of wheigt. So lets finish this fast and start EATING.
If you want to read a better and more detailed
documentation wait for the next release.

1.3 Fields Documentation: Tutorial

What you see:

When starting the program you see a fixed solid in the mid of the screen. You can see the attributes of the solid by looking at its shape and its color.

a black plus means	positiv charge
minus	negativ charge
nothing in it	no charge
filled in blue	solid has no mass
red	solid has mass

Around this fixed solid another solid moves accelerated by the forces of the fixed one. This moving solid has always a negativ charge of one and at least a |mass| of one.

Note: the screen is not proportional. Circles will look like Ellipses. Ellipses will be shown stretched. To estimate the real shape you have to divide the y-distance by two

Change fixed solid:

You can change the parameter of the fixed solid by selecting the Menu Option "Modules/Set fixed solid":
 Select move old solid in the requester.
 In the now opening window click on the solid and move it to another place by clicking the left M-button again.
 Using the right mouse button will leave the solid at its current position.
 You can now change the attributes which are self explaining.
 Click OK to go on with this configuration

Loading a preset:

There are some examples of fields included in the archive. To load them select "Modules/load" and choose the file "MassSpektro".

Change moving solid:

Wait till the moving solid collides with the black barricade. Select "Modules/Set moving solid" and click the right mouse button to leave its start-position where it is. Decrease the mass to its half (and press return after changing a value).
 The solid will now take another path.

Disable Path hold:

If you don't want that the way of the moving solid is shown disable the option "Config/hold". To get rid of the white paths already plotted on the screen press the gadget "clear screen".

Reset sim:

If you want to see the same simulation again press the gadget reset.

Forces:

Reset the sim. And press constantly on the button Forces. Red lines indicate the sum of grav and electric forces, blue the magnetic force.

Probably the lines are too short to please your taste. Change the forces upset with the menu option to one and look again. If they become too long and cross the edge of the sim-screen they are not plotted.

The graph

The graph to the bottom right can show you the absolute value of the acceleration or the velocity. This means the "breaking" and an "acceleration" of the solid with the same force are shown at the same height. To see the graph less detailed set the graph step with "config/graph step" to 1.

Count ticks:

If you want to know the time interval between two events to compare it with another interval then you can't use your digital watch because the time in the simulation does NOT run constantly. See why in the section Technical Use the Count ticks functions instead (best by pressing "t" twice)

Clear all:

Clear all fields and solids on the screen with the menu option. "Modules/clear all"

Set magnetism:

Select the option magnetism and choose whether the fields lines should head into the screen or out of it. Now you can select the strength of the field. Both attributes are shown in the box to the right. A circle with a cross shows that the fields heads into the picture. A circle with a point in it means that the field heads outside. Reset the sim and watch the moving solid moving on a circle. To know why read the chapter Theorie

Setting a barricade:

To set a baricade that can't be passed by the solid select the menu option "Set barricade". Click on the L-MB for the start coordinate. Move to the end coordinate and press it again.

1.4 Fields Documentation: Theoretical

You like it but you don't feel confident to be very skilled in analyzing large equations and thinking in abstract ways? No problem you are that type of person I made this chapter for. Physicist will understand the program without long explanations.

Have you ever tried to move a cupboard from one side of the room to the other? Then you probably have discovered the consequences of mass: the weight. But what is mass itself?

It is not the weight which you have to carry because without gravity this mass wouldn't have any weight. It is the ability of a solid to withstand an external force best expressed by Newton's Axiom:

Acceleration=Force/mass ($a=f/m$)

Note: Acceleration in its physical sense can be positive and negative. If you break your car you accelerate it with negative acceleration.

What does the equation mean?

1. If the force is constant a higher mass means a lower acceleration which is logical when you think of an Alien trying to drag off the earth with his hyperdrive. he won't get far with it even if he has a strong machine.
2. If there is no force there is no acceleration. This seems to be logically too but think of a moving car. If you give no force with your engine it will stop. Of course it wouldn't if you flew with your car through a vacuum. The car gets slower because of forces between its wheels and the ground and because of the air that withstands a movement too.

Let's sum it up: A solid keeps its velocity if no forces accelerate it (A special case is $v=0$). It tries to withstand an acceleration with its mass.

What are these forces that can accelerate him?

We already have spoken about gravity. Two solids produce a pull on each other. The strength of this pull depends on different variables: The mass of the two solids which is obvious. If you have more mass you are pulled down stronger and if the earth would have less mass like the moon you could easily jump farther than Carl Lewis.

Another parameter is the distance between the two solids. For us humans this is not as obvious as the previous point because we always (usually) have the same distance from earth (its radius).

But those people in the space shuttle or in MIR are not very far from earth and are nearly weightless. Newton discovered that the force of gravity is antiproportional not to the distance but to the square of the distance.

This means: If you double your distance between you and earth the force is not halved. It is one fourth of the original force.

To say all this in one equation:

$$F_g = m_1 * m_2 / r^2 \text{ with } F_g \text{ as the force of gravity}$$

m as the masses and r as the distance

Now we can include this equation in the other one for the mass and get the acceleration produced by gravity:

$$a = F / m = m_1 * m_2 / (m * r^2)$$

Now we have three m 's? Of course we have only two. the last m is the same as m_1 . It is both times the mass of the solid we want to know the acceleration of. It is the same and x/x always equals one. So we get the amazing result that the acceleration is not dependant on the mass of the body accelerated:

$$a = m_2 / r^2$$

If this seems to be strange to you you are not alone. Two thousand years of science thought that a solid with a higher mass is accelerated faster until Gallileo Gallilei dropped two balls with different weight from the tower of Pisa. The idea that two solids with different weight are accelerated the same is only so strange because of the force with that the air withdraws a movement. A feather and a ball of steel will fall with the same speed in vacuum.

Load the file "Example1.fld" with the sim
Look what happens if you change the mass of the moving solid. use the button Forces to see that the force increases with the mass.
Set its start velocity to 0 and see that it simply crashes into the fixed solid.

The second force that has to interest us is that between two charged solids.

What will it depend on? Of course on the two charges and of course again on the distance between them. The equation is amazingly similar to that one for F_g .

$$F_e = q_1 * q_2 / r^2 \text{ with } F_e \text{ as the electric force}$$

and q as the two charges

This equation is interesting. We can learn a lot from it about electric forces. Suppose you have two solids with positive charges. Then F_e will be always higher than 0. This means the two solids repel each other. Imagine one is positive the other one negative. Then F_e will be

lower the 0 and the solids pull each other.

This time the acceleration of a solid depends on its mass:

$$a = F / m = q_1 * q_2 / (m * r^2)$$

Load the file "Example2.fld" with the sim
Look what happens if you change the mass
of the moving solid. use the button Forces to
see that the force does not increase with the
mass. look what happens if you give the
fixed solid a negativ charge.

The last force implemented is that of a magnetic field.

You think only iron reacts on magnetism?
Magnetism also affects charged AND moving solids.

The strength of this magnetic force depends
on the velocity and the charge of the solid. Of course
this can't be all or all moving charges would be accelerated
even if there would be no magnetic field. it also depends on
the strength of the magnetic field. This sound complicated and
we have to abtact a bit here. Magnetic forces can not be explained
as easy as the electric forces that can be explained with a fixed
solid that accelerates another one. In this case there is no fixed
solid. Perhaps you think of a magnet but magnetic fields can also
be produced in other ways.

Let us say the magnetic strehgth B is the ability of the magnetic field
to produce a force on a solid with a definite charge and velocity.

This can be expressed in following equation:

$$F_b = B * q * v$$

The stronger the magnetic field, the higher the charge of the solid and
the faster the solid moves - the the stronger the force on it.

To combine it again with the acceleration:

$$a = F / m = B * q * v / m$$

This magnetic force posses a special attribute. Unlike the Gravity
ot the electric forces that always head to one definite point
(the charge or mass that accelerates the solid) the magnetic force
always heads vertical to the direction of the movement of the solid.
That means if a charge would flie on your screen form the left to he right
it would be accelerated to the botton or the top (dependend on the
value of B and q). But only in one moment. In the next its moving direction has
changed a bit under the pressure of the vertical acceleration. Then it is
accelerated in a slightly different direction. This force does NEVER affect
the velocity of the solid. It only changes its direction.

Now think of a solid whose moving direction changes constantly.
Its movement will describe a prefect circle.

Load the file "Example3.fld" with the sim.
 See that the solid moves in a circle. Watch at the graph to see that its velocity stays constant. Use the gadget forces to see the strength of the force. Double the velocity and look at the forces again.
 Use a magnetic field that runs "out of the screen".
 See what has changed.

What happens if there are several forces at the same time?

You have created a sim with more than one fixed solid?
 or with a fixed solid and a magnetic field?

The answer is simple. They can be added. But always look on the direction of them. If you are walking with a more or less good friend through the town suddenly finding a 100.000\$ note lying on the earth and you both pull it because everybody of you wants to have it it won't move. Why? If you both pull with the same force (your friend isn't weaker than you) the forces neutralize each other because they head in the opposite direction. Well in the end the note will be ripped and none of you will get. !Very morally valuable story! ;-)

If the forces do not head in the opposite direction and not in the same direction addition becomes more tricky. But that will not be a subject of this chapter. With a bit inspiration you can guess the resulting force without any knowledge of vector addition.

That's all folks. You should now be able to understand what happens in easy sims. If you want to know more get a physics book or try to understand the technical part :-)

1.5 Fields Documentation: Technical

Note: Handling with float-points in E is a mess so that I preferred to use the functions of the `mathffp` and `mathtrans` library directly. If you don't know what it is all about wait for the next release where it will include the "usual" code.

most important variables: `qx[i],qy[i]` ->locations of fixed solids
`qm[i],qq[i]` ->Mass and charge
`x,y,m` ->location and mass of moving solid
`axnew,aynew` ->acceleration of moving solid
`d` ->interval step

`axnew:=nNULL` Set acceleration to 0
`aynew:=nNULL`

```

i:=1
WHILE (SpFix(qx[i])>0) OR (SpFix(qy[i])>0)
  -> Are there still fixed solids to calculate?
  ax,ay:=acceleration(SpSub(qx[i],x),SpSub(qy[i],y),i)
  -> Calculate a for the fixed solid i and give the relativ
      location of the moving solid to i as parameter
  Continue reading at PROC acceleration()
  axnew:=SpAdd(axnew,ax)
  aynew:=SpAdd(aynew,ay)
  -> Add all acelerations
  INC i1
ENDWHILE

IF magnet_flag>0      -> Is there a B-Field?
  b:=div(m,SpFlt(magnet_strength)) ->Calcualte b
  IF magnet_flag=1      -> B into pic
    axnew:=SpAdd(SpMul(vy,b),axnew) -> Vector Product of v and B
    aynew:=SpSub(SpMul(vx,b),aynew) ad it to current a
  ELSE                  -> B out of pic
    axnew:=SpSub(SpMul(vy,b),axnew)
    aynew:=SpAdd(SpMul(vx,b),aynew)
  ENDIF
ENDIF

dax:=SpMul(w,SpSub(axold,axnew))
  -> Estimate how a will change until the end of the next interval
      by comparing the current value with the old one
day:=SpMul(w,SpSub(ayold,aynew))

vx:=SpAdd(vx,SpMul(SpAdd(axnew,div(SpFlt(2),dax)),div(SpFlt(2),d)))
  -> Estimate the average value of a during the next intervall
      Compute v(d/2) which is the average velocity.
vy:=SpAdd(vy,SpMul(SpAdd(aynew,div(SpFlt(2),day)),div(SpFlt(2),d)))

x:=SpAdd(x,SpMul(vx,d))
  -> How far will the solid move in the interval d.
      Add it to the current position.
y:=SpAdd(y,SpMul(vy,d))

vx:=SpAdd(vx,SpMul(SpAdd(axnew,div(SpFlt(2),dax)),div(SpFlt(2),d)))
  -> Add the "rest of a" to v to get the value of it
      at the end of the interval
vy:=SpAdd(vy,SpMul(SpAdd(aynew,div(SpFlt(2),day)),div(SpFlt(2),d)))

ayold:=aynew -> retain value of a
axold:=axnew

v:=vector_length(vx,vy) -> Calculate the amount of v and don't care
                        about the direction of the vector

w:=SpAbs(div(d,div(v,SpFlt(1))))
  -> Only for calculation of dax and day. If d changes then
      they have to be multiplied with dnew/dold to
      get the correct values for the interval dnew

d:=SpAbs(div(v,SpFlt(1)))
  -> Calculate length of next intervall

```

```

                                To make sure that there are no
                                "extreme jumps" at high velocity
                                make d antiproportional to v.
IF SpFix(SpMul(d,SpFlt(100)))>30 THEN d:=div(SpFlt(3),SpFlt(1))
                                -> Is d getting too high at low
                                velocity? Set a maximum.

```

```

PROC div (a,b) -> Dont divide by 0 ;- )
  IF SpTst(a)<>0 THEN RETURN SpDiv(a,b) ELSE RETURN b
ENDPROC

```

```

PROC vector_length(x,y)
ENDPROC SpSqrt(SpAdd(SpMul(x,x),SpMul(y,y)))

```

```

PROC acceleration(rx,ry,i)
  DEF r,a:LONG,ax,ay,w

  r:=vector_length(rx,ry)          -> Don't care about the direction of
                                   r> only get the amount

  w:=SpAcos(div(r,rx))             -> get the angle between r> and its rx
                                   Komponent

  a:=div(m,div(SpMul(r,r),SpMul(SpNeg(qq[i]),SpFlt(100000))))
                                   -> calculate the amount of a
                                   with  $F=k*ql*q2/r^2$ 
                                   don't care about the Electric field constant
                                   cause we don't use usual dimensions
                                   Multiply with 100000 to get a value
                                   high enough to change x and y visibly
                                   With ql of the moving solid being always -1
                                   the equation is  $a=F/m=-q/(r^2*m)$ 

  ax:=SpMul(SpCos(w),a)
                                   -> Dismantle a in its x and its y Komponent. We don't have
                                   to care about the direction of ax because its already
                                   in w
  ay:=SpMul(SpMul(SpSin(w),a),SpFlt(SpTst(ry)))
                                   -> Calculate the direction of the y Komponent by testing
                                   the location relativ to the fixed solid against 0

  a:=div(SpMul(r,r),SpMul(SpNeg(qm[i]),SpFlt(100000)))
                                   -> Now do the same with the Gravity
                                   with  $F=k*m1*m2/r^2$  and  $a=F/m1=m2/r^2$ 
                                   and add it to the current a>
  ax:=SpAdd(ax,SpMul(SpCos(w),a))
  ay:=SpAdd(ay,SpMul(SpMul(SpSin(w),a),SpFlt(SpTst(ry))))

  RETURN ax,ay
ENDPROC

```

1.6 Fields Documentation: Examples

Information available about following fld's:
 Mass Spectrograph

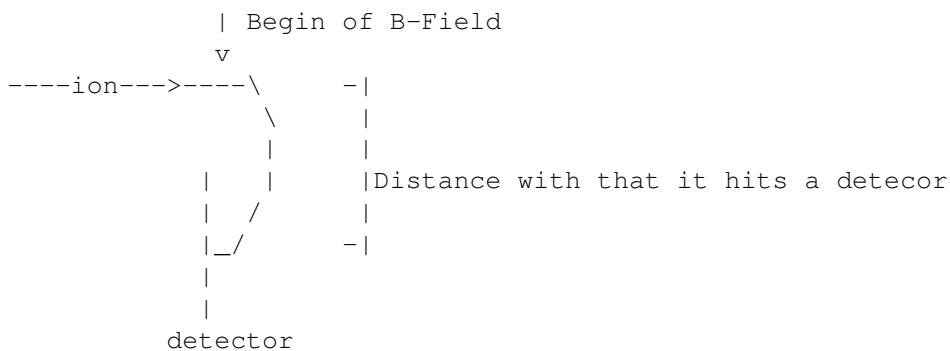
Do you have created own fld files
 that simulate something specific
 or that draw interesting patterns?
 Please let me know.

1.7 Fields Documentation: Examples/Massspectograph

The most important purpose of mass spectrographs is
 the estimation of the frequency of definite atoms
 in different substances.

First the atoms have to be ionised. Othwereise they
 would not react on electric or magnetic fields.

To divide atoms of different masses they are sent through
 a magnetic field (B-Field).



The Force F_b that heads perpendicular
 on the v acts as a zentripetalforce.
 (sorry for all this strange expressions but I don't know
 the exact translations of the german technical terms)

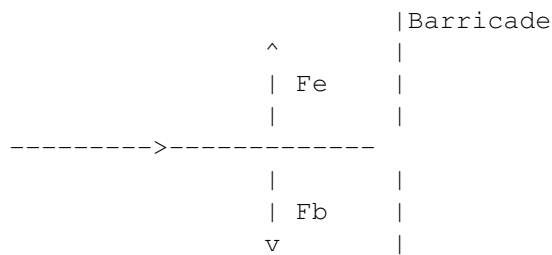
This Zentripelforce $F_b = Bev$ equals the
 Zentrifugalforce $m \cdot v^2 / r$

$$F_z = F_b \Rightarrow m \cdot v^2 / r = B \cdot q \cdot v \Rightarrow r = v \cdot m / (B \cdot q)$$

This means the higher the mass of the solid the bigger
 the radius r . With other words: the distance d with that
 a solid crashes on a detector is proportional to its
 mass.

But the Masses can only be compared if all other variables
 in the equation $r = v \cdot m / (B \cdot q)$ are constant
 B is the strength of the magnetic field wich can be made constant
 easily. Q is the Charge of the ion which is usually e or $-e$
 if the Atom has lost or "earned" one electron.
 But v can change.

To prevent that ions with different velocities enter the B-Field they are first send through a crossed electric and magnetic Field.



They pass it without being deflected only if the two Forces F_e and F_b have the same strength.

$$F_e = F_b \Rightarrow q \cdot E = q \cdot B \cdot v \Rightarrow v = E/B$$

Only the ions with the velocity $v = E/B$ pass the barricade.

With this knowledge m can be calculated:

$$m = r \cdot B \cdot q / v = r \cdot B \cdot q \cdot B / E = d \cdot q \cdot B^2 / 2v$$

In the sim try to use different masses and velocities for the moving solid but do not change the start position. It works best if it is exactly in the mid of the E-Field.

Use the forces gadget to see that in the E-B-Field both forces neutralize each other.

1.8 Fields Documentation: Future

What could be done? A lot:

- a) Simulation of more than one moving solid that influence each other
- b) Numbers in usual dimensions (g, Cb, m , etc.)
- c) 3 dimensional Simulation
- d) Making it faster.
- e) Magnetic Field only for a specific screen region
- f) homogenous electric fields for specific screen regions
- g) Include laws of quantum mechanics (has only sense if b) is included)
- make barricades able to screen electric fields
- use a proportional screen

I am not sure what I will include. It is too much to do it all. If you have a special priority write. I will include the things that are wished by the largest number of people.

1.9 Fields Documentation: History

V 1.0: September 1996 First public Version

1.10 Fields Documentation: Author

If you want to say "This is the best I ever have seen"
or "The program sucks" feel free to write to

Timm Baumeister
Ihmerter Str.77
58762 Altena
Germany
email: timm@thunder.art-line.de

All bug reports, comments, suggestions and donations ;-)
are welcome. If you get no reply try to email me again
because my provider breaks down at least once a month.

So long and thanks for all the fish...

P.S. Get another program:

Aminet/misc/sci/Epi-Sim simulating robber prey relations
and wait for a game simulating a nuclear power station
if that project can ever be finished (phew!).

1.11 Fields Documentation: Epi Sim

The program simulates the relationship between a
robber and a prey population.

Feature list:

- Animation field: lets you see what every single individuum does
 - Graph: Shows the density of both populations confirming the laws of Volterra
 - following attributes are configurable:
Reproduction time/First Reproduction/Natural Life expectancy/
Time still starving (for robber)/possibility of refuge
(for prey)/smooth reproduction
 - Decrease option to analyze the consequences of insecticides
 - Loading and Saving of parameter configurations
 - Comfortable usement
 - Documenation that includes explanation of robber
prey-relations and the laws of Volterra
-