reference

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WRITTEN BY		February 12, 2023	

REVISION HISTORY			
NUMBER	DATE	DESCRIPTION	NAME

Contents

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!

                 Technical
                 for all those who like programming

                 Examples
                 About the fld files included

                 History
                 what`s new?

                 Future
                 what could be done if I had more time?

                 Author
                 how you can contact me.
```

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 ist is.
Decrease the mass to its half (and press return after changing a value).
The solid will now take another path.

Diasable Path hold:
If you don't want that the way of the moving solid is shown disable the option "Config/plothold".
To get rid of the white pathes 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 absolut 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 heigth.
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 wheigt.
But what is mass itself?

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

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

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

What does the equation mean?
1. If the force is constant a higher mass means a lower
   acceleration wich 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 flyed with you car
   through a vacuum. The car gets slower because
   of forces between is wheels and the ground
   and because of the air that withstands a movement too.

Lets summ 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 differnt
  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 farer than Carl Louis.

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 wheigtless.
Newton discovered that the force of gravity is antiproportional not to the distance but to the square of the distance.
This means: If you doubble your distance between you and earth the force is not halfed. It is one fourth of the original force.

To say all this in one equation:

```
      Fg=m1*m2/r^2 with Fg 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 = m1 *m2 / ( m * r^2 )
```

Now we have three m's? Of course we have only two. the last m is the same as m1. 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= m2 / r^2
```

If this seems to be strange to you you are not alone. Two thousend years of science thought that a solid with a higher mass is accelerated faster until Gallileo Gallilei dropped two balls with different wheigt from the tower of Pisa. The idea that two solids with different wheigt 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 Fg.

```
Fe = q1 * q2 / r^2 with Fe as the electric force
                        and q as the two charges
```

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

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

```
a= F / m = q1 * q2 / ( 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 abstact 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:

```
Fb = 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 stayes constant. Use the gadget
  forces to see the strength of the force. Doubble 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 sveral 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 liing
  on the earth and you both pull it beacuse 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 beacuse they head in the opposite direction.
  Well in the end the note will be ripped and none of you
  will get. !Very moraly valuable story! ;-)

  If the forces do not head in the oppsite 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.

Thats all folks. You should now be able to undesrstand
what happens in easy sims. If you want to know more
get a physic 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 prefered 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 i
      will include the "usual" code.



most improtant 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:=nULL      Set acceleraton to 0
        aynew:=nULL
        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
                                          Komponet
   a:=div(m,div(SpMul(r,r),SpMul(SpNeg(qq[i]),SpFlt(100000))))
                     -> calculate the amount of a
                        with F=k*q1*q2/r^2
                        don't care about the Electric field constant
                        cause we don't use usual dimensions
                        Multiplicate with 100000 to get a value
                        high enough to change x and y visibly
                        With q1 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 avaiable 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/Masspectograph

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 ionisied. 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).

```
              | Begin of B-Field
              v
 ----ion--->----\     -|
                 \     |
                 |     |
             |   |     |Distance with that it hits a detecor
             |  /      |
             |_/      -|
             |
             |
           detector
```

The Force Fb 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 Fb=Bev equals the
Zentrifugalforce m*v^2/r

Fz=Fb => m*v^2/r=B*q*v => r=v*m/(B*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*m/(B*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.

```
                         |Barricade
                ^        |
                | Fe     |
                |        |
---------->-------------
                |        |
                | Fb     |
                v        |
```

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

Fe=Fb => q*E=q*B*v => v=E/B
Only the ions with the velocity v=E/B pass the
barricade.

With this knowledge m can be calculated:

m=r*B*q/v=r*B*q*B/E=d*q*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, sugestions 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
```