CP1 Blatt6 Abgabe Lapp & Brieden

erstellt von Tobias Lapp und Sven Brieden am 30.11.2017

Aufgabe 6.1 Many body equilibria in 2d

harmonic potential	$V_h = \frac{\vec{x}^2}{2}$	in the code its the function Vp
repulsive potential	$V_{12}(\vec{x}_1, \vec{x}_2) = -\log\|\overrightarrow{x_1} - \overrightarrow{x_2}\|$	in the code its the function Vpp
the resulting potential for particle i	$V(\overrightarrow{x_i}) = \overrightarrow{x_i}^2 \cdot 0.5 + \sum_{i \neq j}^{N} -\log\|\overrightarrow{x_i} - \overrightarrow{x_j}\|$	in the code its the function V

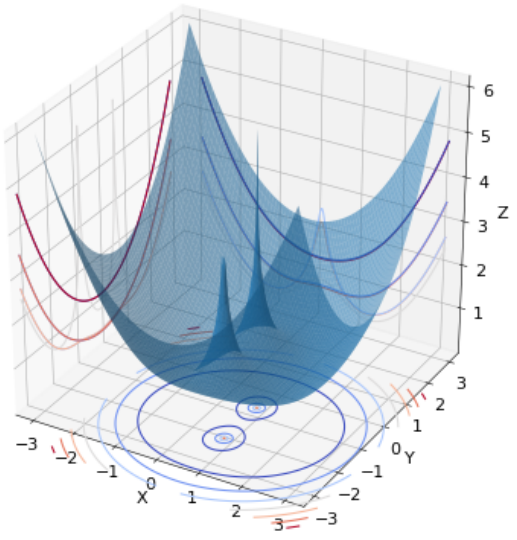
In [508]:
```
Vp = lambda x: np.linalg.norm(x)**2 / 2
Vpp = lambda x1, x2: -np.log(np.linalg.norm(x1-x2))
def V(neue_position, particle_nr, dim):
    position = x_liste[i,particle_nr]
    position[dim] = neue_position
    V = Vp(position)
    for particle in range(N):
        if particle != particle_nr:
            V += Vpp(position, x_liste[i, particle])
    return V
def Main2(N):                           # iterating over 2,3,4 number of particles
    x_liste = np.random.rand(N,2)*2 -1      # startingpoins for all particles
    iterations = int(N * N /2)              # iterations to find the equilibria of many body

    for i in range(iterations):
        for p in range(N):
            x_liste[p,0] = fmin(V,x_liste[p,0],args=(p,0,))
            x_liste[p,1] = fmin(V,x_liste[p,1],args=(p,1,))

    print("Die Distanz zum Mittelpunkt ist bei %i Teilchen gemittelt: %.4f"%(N,np.mean([np.linalg.norm(x_liste[-1
,o]) for o in range(N)])))
    plot_3d_special()
```

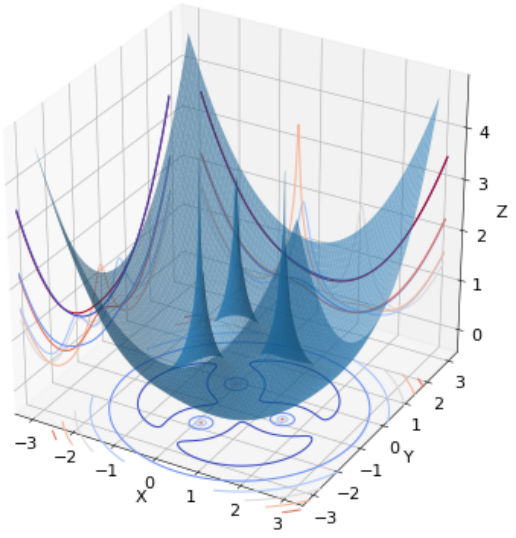
In [509]:
```
Many_body_equilibria_in_2d(2)
```

```
Die Distanz zum Mittelpunkt ist bei 2 Teilchen gemittelt: 0.6998
```



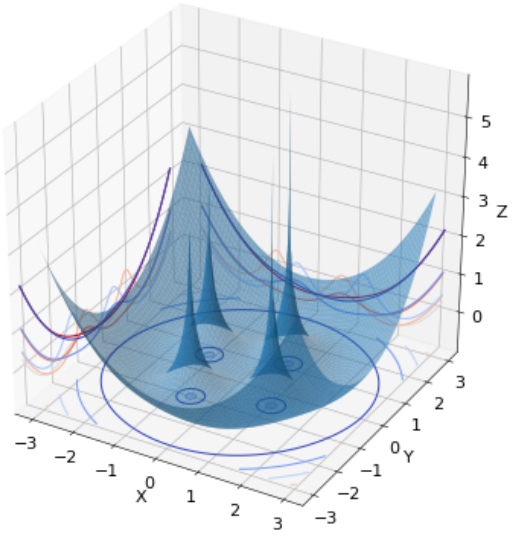
In [510]:
```
Many_body_equilibria_in_2d(3)
```

```
Die Distanz zum Mittelpunkt ist bei 3 Teilchen gemittelt: 1.0000
```



In [511]:
```
Many_body_equilibria_in_2d(4)
```

```
Die Distanz zum Mittelpunkt ist bei 4 Teilchen gemittelt: 1.2251
```



Aufgabe 6.2. LU decomposition for tridiagonal matrices

In [ ]:
```
#A=(a c 0 0) = L * U
#   b a c 0
#   0 b a c
#   0 0 b a
size = 10#Size of tridiagonal quare matrix mxm
A= scipy.zeros((size,size)) #Matrix mit Nullen
L= scipy.zeros((size,size))
U= scipy.zeros((size,size))

b= np.zeros(10)
b[0]=1
```

In [ ]:
```
#Erstellen der Ausgangsmatrix A
for z in range(size):   # Zeilen
   for i in range(size): # Spalten
       if z==i:
           A[z][i]=2   # Hauptdiagonale ai
       if z==i-1:
           A[z][i]=-1  # obere Diagonale ci
       if z==i+1:
           A[z][i]=-1  # untere Diagonale bi

da = np.zeros(size)
dc = np.zeros(size)
db = np.zeros(size)
```

In [ ]:
```
# indizes der diagonalenelemente
ai=0
bi=1
ci=1

#Speichern der relevanten diagonalen von A
for z in range(size):   # Zeilen
   for i in range(size): # Spalten
       if z==i:
           da[ai] = A[z][i]   # Hauptdiagonale ai
           ai=ai+1
       if z==i-1:
           dc[ci] = A[z][i]  # obere Diagonale ci
           ci=ci+1
       if z==i+1:
           db[bi] = A[z][i]  # untere Diagonale bi
           bi=bi+1
```

In [ ]:
```
# diagonalen von L und U die keine Nullen enthalten
L_u = np.zeros(size)
U_m = np.zeros(size)
U_o = np.zeros(size)

# Berechnung der Elemente der L-und U-Diagonalen
U_m[0]=da[0]

for i in range(1,size):
    L_u[i] = db[i]/U_m[i-1]
    U_m[i] = da[i]-L_u[i]*dc[i-1]

# indizes der diagonalenelemente
li=1
ui=0
ci=1
```

In [ ]:
```
#Füllen der L und U Matrizen
for z in range(size):
   for i in range(size):
       if z==i:
           L[z][i]=1   # Hauptdiagonale
           U[z][i]=U_m[ui]
           ui=ui+1
       if z==i-1:
           U[z][i] = dc[ci]    # obere Diagonale
           ci=ci+1
       if z==i+1:
           L[z][i]= L_u[li]  # untere Diagonale
           li=li+1
```

In [ ]:
```
#Berechnung mit L U
y = scipy.zeros(size)
x = scipy.zeros(size)

for i in range(size):
    y[i] = b[i]
    for k in range(i):
        y[i] -= L[i,k]*y[k]

for i in range(size-1,-1,-1):
    x[i] = y[i]
    for k in range(i+1,size):
        x[i] -= U[i,k]*x[k]
    x[i] *= 1./U[i,i]
```

In [515]:

```
print("Lösung mit L-U-Zerlegung:"), print(x), print("\n Benutzung von Solve mit A und b:")
print(scipy.linalg.solve(A,b))

A_dec=np.dot(L,U)
print("\n Fehler bei Zerlegung, da Element A[1,1]falsch:"), print(A_dec)
print("L = "),print(L)
print("\n U = "),print(U)
```

```
Lösung mit L-U-Zerlegung:
[ 0.725  0.45   0.4    0.35   0.3    0.25   0.2    0.15   0.1    0.05 ]

 Benutzung von Solve mit A und b:
[ 0.90909091  0.81818182  0.72727273  0.63636364  0.54545455  0.45454545
  0.36363636  0.27272727  0.18181818  0.09090909]

 Fehler bei Zerlegung, da Element A[1,1]falsch:
[[ 2.  -1.   0.   0.   0.   0.   0.   0.   0.   0. ]
 [-1.   2.5 -1.   0.   0.   0.   0.   0.   0.   0. ]
 [ 0.  -1.   2.  -1.   0.   0.   0.   0.   0.   0. ]
 [ 0.   0.  -1.   2.  -1.   0.   0.   0.   0.   0. ]
 [ 0.   0.   0.  -1.   2.  -1.   0.   0.   0.   0. ]
 [ 0.   0.   0.   0.  -1.   2.  -1.   0.   0.   0. ]
 [ 0.   0.   0.   0.   0.  -1.   2.  -1.   0.   0. ]
 [ 0.   0.   0.   0.   0.   0.  -1.   2.  -1.   0. ]
 [ 0.   0.   0.   0.   0.   0.   0.  -1.   2.  -1. ]
 [ 0.   0.   0.   0.   0.   0.   0.   0.  -1.   2. ]]
L =
[[ 1.          0.          0.          0.          0.          0.          0.
   0.          0.          0.        ]
 [-0.5         1.          0.          0.          0.          0.          0.
   0.          0.          0.        ]
 [ 0.         -0.5         1.          0.          0.          0.          0.
   0.          0.          0.        ]
 [ 0.          0.         -0.66666667  1.          0.          0.          0.
   0.          0.          0.        ]
 [ 0.          0.          0.         -0.75        1.          0.          0.
   0.          0.          0.        ]
 [ 0.          0.          0.          0.         -0.8         1.          0.
   0.          0.          0.        ]
 [ 0.          0.          0.          0.          0.         -0.83333333
   1.          0.          0.          0.        ]
 [ 0.          0.          0.          0.          0.          0.
  -0.85714286  1.          0.          0.        ]
 [ 0.          0.          0.          0.          0.          0.          0.
  -0.875       1.          0.        ]
 [ 0.          0.          0.          0.          0.          0.          0.
   0.         -0.88888889  1.        ]]

 U =
[[ 2.         -1.          0.          0.          0.          0.          0.
   0.          0.          0.        ]
 [ 0.          2.         -1.          0.          0.          0.          0.
   0.          0.          0.        ]
 [ 0.          0.          1.5        -1.          0.          0.          0.
   0.          0.          0.        ]
 [ 0.          0.          0.          1.33333333 -1.          0.          0.
   0.          0.          0.        ]
 [ 0.          0.          0.          0.          1.25       -1.          0.
   0.          0.          0.        ]
 [ 0.          0.          0.          0.          0.          1.2        -1.
   0.          0.          0.        ]
 [ 0.          0.          0.          0.          0.          0.
   1.16666667 -1.          0.          0.        ]
 [ 0.          0.          0.          0.          0.          0.          0.
   1.14285714 -1.          0.        ]
 [ 0.          0.          0.          0.          0.          0.          0.
   0.          1.125      -1.        ]
 [ 0.          0.          0.          0.          0.          0.          0.
   0.          0.          1.11111111]]
```

Out[515]:

```
(None, None)
```