ソースファイル名：lbmhtwo.for，実行ファイル名：lbmhtwo.out

```
$ cp   ../common/lbmhtwo_ori.for   .    ($ cp   ../common/lbmhtwo_oripro.for   .   )
$ cp   lbmhtwo_ori.for   lbmhtwo.for    ($ cp   lbmhtwo_oripro.for   lbmhtwo.for )
$ vi   lbmhtwo.for
$ gfortran   -o   lbmhtwo.out     lbmhtwo.for
$ ./ lbmhtwo.out
```

```
      program twophase

      real*8   cx(7), cy(7), f(7,33,33), f0(7,33,33)
      real*8   ux(33,33), uy(33,33), rho(33,33)
      real*8   ux0, uy0, rho0, tau, ntime
      real*8   kap, a, b, t, noise
      integer nfnl1, nfnl2, nx, ny

      rho0 = 3.23933; ux0   = 0.00; uy0 = 0.00;
      nx =   30; ny =   30
      nfnl1 = 100; nfnl2 = 10; ntime = 0.;
      tau = 1.0; noise = 0.0500
      kap = 0.01; a = 9./49.; b = 2./21.; t = 0.56;

      call initial(cx,cy,f,f0,ux,uy,rho,nx,ny,
     .             ux0,uy0,rho0,kap,a,b,t,noise)

100   do n1 = 1, nfnl1
       do n2 = 1, nfnl2

        ntime = ntime + 1

        call phys(cx,cy,f,ux,uy,rho,nx,ny)
        call equiblium(                    )
        call collide(          )
        call stream(f,nx,ny)

       end do

       call plot(rho,nx,ny,ntime)
      end do
      call exceldata(rho,nx,ny)
      end
c
```

```
      subroutine initial(cx,cy,f,f0,ux,uy,rho,nx,ny,
     .                   ux0,uy0,rho0,kap,a,b,t,noise)
c-----------------------------------------------------------------------
      real*8   cx(7), cy(7), f(7,33,33), f0(7,33,33)
      real*8   ux(33,33), uy(33,33), rho(33,33)
      real*8   ux0, uy0, rho0, pi, kap, a, b, t, noise
      integer nx, ny

      pi = 4.0*atan(1.0)
      cx(1) =   0.0
      cy(1) =   0.0
      do k = 2,7
        cx(k) = cos(pi/3*(k-2))
        cy(k) = sin(pi/3*(k-2))
      enddo

        do i = 1,nx
          do j = 1,ny
            ux(i,j) = ux0; uy(i,j) = uy0; rho(i,j) = rho0
          end do
        end do

      call equiblium(                              )

      do k = 1,7
        do i = 1,nx
          do j = 1,ny
            f(k,i,j) = f0(k,i,j)
          end do
        end do
      end do

      call SRAND(1)
      do k = 1,7; do i = 1,nx; do j = 1,ny
          f(k,i,j) = (1. + noise*(rand(0) - 0.5))*f(k,i,j)
      enddo; enddo; enddo

      return
      end
c
```

```
      subroutine equiblium(                              )
c-----------------------------------------------------------------------
      real*8    cx(7), cy(7), f0(7,33,33)
      real*8    ux(33,33), uy(33,33), rho(33,33)
      real*8    kap, a, b, t
      real*8    u2, p0, dd, tmp, rhox, rhoy, rhoxx, rhoyy
      integer nx, ny
      integer i, i1, i2, i3, i4, i5, i6, i7, k, sflag
      integer j, j1, j2, j3, j4, j5, j6, j7, ntmp

      sflag = 1 ! upwind difference
c     sflag = 2 ! centered difference

      do i = 1,nx
       do j = 1,ny
        u2 = ux(i,j)**2 + uy(i,j)**2
       p0 =                                  
       j1 = j;
       j2 = j; j3 = j + 1; j4 = j + 1
       j5 = j; j6 = j - 1; j7 = j - 1
       if(j .eq. ny) then; j3 =    1; j4 =    1; endif
       if(j .eq.    1) then; j6 = ny; j7 = ny; endif

       if(mod(j,2).eq.0) then
        i5 = i - 1;
        i1 = i       ; i4 = i       ; i6 = i
        i2 = i + 1; i3 = i + 1; i7 = i + 1
        if(i .eq. nx) then; i2 =    1; i3 =    1; i7 =    1; endif
        if(i .eq.    1) i5 = nx
       else
        i4 = i - 1; i5 = i - 1; i6 = i - 1
        i1 = i       ; i3 = i       ; i7 = i
        i2 = i + 1;
        if(i .eq.    1) then; i4 = nx; i5 = nx; i6 = nx; endif
        if(i .eq. nx) i2 = 1
       endif

        if( sflag .eq. 2 ) then
         rhox = (rho(i2,j2) - rho(i5,j5))/2.
         rhoy = ((rho(i3,j3) + rho(i4,j4))
```

```
.            -    (rho(i6,j6) + rho(i7,j7)))/(sqrt(3.)/2.)
     endif

      dd = (rho(i2,j2) - 2.0*rho(i1,j1) + rho(i5,j5))
     .       + (0.5*(rho(i3,j3) + rho(i4,j4)) -    2.0*rho(i1,j1)
     .       +    0.5*(rho(i6,j6) + rho(i7,j7)))/(sqrt(3.)/2.)**2

     f0(1,i,j) =
```

```
     do k = 2,7
      tmp = cx(k)*ux(i,j) + cy(k)*uy(i,j)

      if( sflag .eq. 1 ) then
       if(cx(k) .ge. 0.) then
        rhox = rho(i1,j1) - rho(i5,j5)
        ntmp = i5 - 1; if(i5.eq. 1) ntmp = nx
        rhoxx= rho(i1,j1) - 2.*rho(i5,j5) + rho(ntmp,j5)
       else
        rhox = rho(i2,j2) - rho(i1,j1)
        ntmp = i2 + 1; if(i2 .eq. nx) ntmp = 1
        rhoxx= rho(ntmp,j2) - 2.*rho(i2,j2) + rho(i1,j1)
       endif
       if(cy(k) .ge. 0.) then
        rhoy = (rho(i1,j1)
     .            -    0.5*(rho(i6,j6) + rho(i7,j7)))/(sqrt(3.)/2.)
        ntmp = j6 - 1; if(j6 .eq. 1) ntmp = ny
        rhoyy= (rho(i1,j1) + rho(i1,ntmp)
     .            - (rho(i6,j6) + rho(i7,j7)))/(sqrt(3.)/2.)**2
       else
        rhoy = (0.5*(rho(i3,j3) + rho(i4,j4))
     .          -    rho(i1,j1))/(sqrt(3.)/2.)
        ntmp = j3 + 1; if(j3 .eq. ny) ntmp = 1
        rhoyy= (rho(i1,j1) + rho(i1,ntmp)
     .            - (rho(i3,j3) + rho(i4,j4)))/(sqrt(3.)/2.)**2
       endif
       dd    = rhoxx + rhoyy
      endif

      dd = (rho(i2,j2) - 2.0*rho(i1,j1) + rho(i5,j5))
```

```
     .          + (0.5*(rho(i3,j3) + rho(i4,j4)) -    2.0*rho(i1,j1)
     .          +    0.5*(rho(i6,j6) + rho(i7,j7)))/(sqrt(3.)/2.)**2

                f0(k,i,j) = (
                             
                             
                             
                             
                             
                             
                             
                             
                             
                end do
              end do
            end do

            return
            end
c
            subroutine stream(f,nx,ny)
c-----------------------------------------------------------------------
            real*8    f(7,33,33), tmp(7,33,33)
            integer nx, ny
            integer i, i1, i2, i3, i4, i5, i6, i7, k
            integer j, j1, j2, j3, j4, j5, j6, j7

            do k = 1,7
              do i = 1,nx
                do j = 1,ny
                  tmp(k,i,j) = f(k,i,j)
                end do
              end do
            end do
c
            do i = 1,nx
              do j = 1,ny
                j1 = j;
                j2 = j; j3 = j + 1; j4 = j + 1
                j5 = j; j6 = j - 1; j7 = j - 1
                if(j .eq. ny) then; j3 =    1; j4 =    1; endif
                if(j .eq.    1) then; j6 = ny; j7 = ny; endif
```

```
          if(mod(j,2).eq.0) then
           i5 = i - 1;
           i1 = i       ; i4 = i       ; i6 = i
           i2 = i + 1; i3 = i + 1; i7 = i + 1
           if(i .eq. nx) then; i2 =    1; i3 =    1; i7 =    1; endif
           if(i .eq.    1) i5 = nx
          else
           i4 = i - 1; i5 = i - 1; i6 = i - 1
           i1 = i       ; i3 = i       ; i7 = i
           i2 = i + 1;
           if(i .eq.    1) then; i4 = nx; i5 = nx; i6 = nx; endif
           if(i .eq. nx) i2 = 1
          endif
          f(1,i,j) = tmp(1,i,j)
          f(2,i2,j2) = tmp(2,i,j)
          f(3,i3,j3) = tmp(3,i,j)
          f(4,i4,j4) = tmp(4,i,j)
          f(5,i5,j5) = tmp(5,i,j)
          f(6,i6,j6) = tmp(6,i,j)
          f(7,i7,j7) = tmp(7,i,j)
         enddo
        enddo

        return
        end
c
        subroutine collide(          )
c-----------------------------------------------------------------------
        real*8    f(7,33,33), f0(7,33,33), tau
        integer nx, ny
        integer i, j, k

        do k = 1,7
         do i = 1,nx
          do j = 1,ny
           f(k,i,j) = f(k,i,j) -
          end do
         end do
        end do
```

```
      return
      end
c
      subroutine phys(cx,cy,f,ux,uy,rho,nx,ny)
c-----------------------------------------------------------------------
      real*8    cx(7), cy(7), f(7,33,33)
      real*8    ux(33,33), uy(33,33), rho(33,33)
      integer nx, ny
      integer i, j, k

      do i = 1,nx
       do j = 1,ny
        ux(i,j) = 0; uy(i,j) = 0; rho(i,j) = f(1,i,j);
        do k = 2,7
          ux(i,j) =
          uy(i,j) =
         rho(i,j) =
          end do
         end do
      end do

      do i = 1,nx
       do j = 1,ny
        if (rho(i,j) .ne. 0.) then
          ux(i,j) =   ux(i,j)/rho(i,j)
          uy(i,j) =   uy(i,j)/rho(i,j)
        else
          ux(i,j)   = 0.
          uy(i,j)   = 0.
        endif
          end do
      end do

      return
      end

      subroutine plot(rho,nx,ny,ntime)
c-----------------------------------------------------------------------
```

```
      real*8 rho(33,33), rhomax, rhomin, rhosum, ntime
      integer nx, ny
      character a(33,33)

      rhomax = -1000; rhomin = 1000; rhosum = 0.
      do i = 1, nx; do j = 1, ny;
        if( rho(i,j) .ge. rhomax) rhomax = rho(i,j)
        if( rho(i,j) .le. rhomin) rhomin = rho(i,j)
        rhosum = rhosum + rho(i,j)/nx/ny
      enddo; enddo;

      write(*,'(a5,f15.5)') 'Time:', ntime
      write(*,*) 'density(maximum)                    (minimum)                (net)'
      write(*,'(3f20.12)')    rhomax, rhomin, rhosum

      do i = 1, nx; do j = 1, ny
         if(rho(i,j) .le. rhomax*1.0                    ) a(i,j)= '9'
         if(rho(i,j) .le. rhomax*0.9 + rhomin*0.1) a(i,j)= '8'
         if(rho(i,j) .le. rhomax*0.8 + rhomin*0.2) a(i,j)= '7'
         if(rho(i,j) .le. rhomax*0.7 + rhomin*0.3) a(i,j)= '6'
         if(rho(i,j) .le. rhomax*0.6 + rhomin*0.4) a(i,j)= '5'
         if(rho(i,j) .le. rhomax*0.5 + rhomin*0.5) a(i,j)= '4'
         if(rho(i,j) .le. rhomax*0.4 + rhomin*0.6) a(i,j)= '3'
         if(rho(i,j) .le. rhomax*0.3 + rhomin*0.7) a(i,j)= '2'
         if(rho(i,j) .le. rhomax*0.2 + rhomin*0.8) a(i,j)= '1'
         if(rho(i,j) .le. rhomax*0.1 + rhomin*0.9) a(i,j)= '0'
      end do; end do

         do j = ny,1,-1
           write(*,*) (a(i,j),i = 1,nx)
         end do
         write(*,*) '*----------------------------*'

      return
      end

      subroutine exceldata(rho,nx,ny)
c-----------------------------------------------------------------------
      real*8    rho(35,35)
      integer nx, ny
```

```
      open(unit = 10, file = 'lbmtwo', status= 'unknown')
       do [      ]
         write[                    ]
       end do
      close(10)

200   format(1x, 30f15.10)

      return
      end
```

《結果》

Time: 1000.00000

density(maximum)	(minimum)	(net)
4.552681020550	2.579422043980	3.253749912337