Notes on Lgapack Fhp6_simp

```
Params.h file

#define NX 16
#define NY 40
#define TPRINT 4000000
#define TMAX 4000000
#define DENSITY 0.5
#define FORCING_RATE .0001
#define TAVG 4000000



#define PARABOLAS 1
#if PARABOLAS
#define WALL_THICKNESS 1
#endif
```

4,000,000 time steps, averaging all data

Rearrange

$$u(x) = \frac{G^*}{2\mu}(a^2 - x^2)$$

to solve for kinematic viscosity ν based on maximum or mean velocity.

Using fhp6_simp4.c

Velocities

measured max	measured mean	mean/max velocity ratio
0.010865	0.006945	0.639232 (should be 0.666…)

Viscosities

measured max	measured mean	predicted viscosity
1.166621	1.368776	1.208333 (visc_sukop.m)

Predicted ν is calculated using the equation in Wolf-Gladrow and Rothman and Zaleski:

$$\nu = \frac{1}{12 f (1 - f)^3} - \frac{1}{8}$$

where f is the particle density per link.

Using fhp6_simp.c (this model has 4-particle collisions; FHP-III of Wolf-Gladrow and Rothman and Zaleski?)

Velocities

measured max	measured mean	mean/max velocity ratio
0.025449	0.016279	0.639687

Viscosities

measured max	measured mean	predicted viscosity
0.498056	0.583945	0.541667 (original Lgapack visc.m)
0.498056	0.583945	1.208333 (visc_sukop.m; wrong theoretical formula)

The expression used to compute the viscosity in the original Lgapack visc.m script is

$$\nu = \frac{1}{12f(1-f)}\frac{1}{\left(-2f+2f^2+1\right)} - \frac{1}{8}$$

It differs from the FHP III model viscosities listed in Rothman and Zaleski (Table 4.1) and Wolf-Gladrow (Table 3.2.2), but these are 7-velocity (rest particle) models so difference is not unexpected. Unfortunately, I don't know where the original visc.m formula comes from.

Differences between files

```
$ diff fhp6_simp.c fhp6_simp4.c
96c96
<  FILE  *fpxmom, *fpymom, *fpmass, *solidfd, *fPtrSolid;
---
>  FILE  *fpxmom, *fpymom, *fpmass, *solidfd;
99,100c99
<  float dR, phi;
<  int iAngle,nAngles, iR;
---
>
106c105
<  seed  -= (long) time(0);
---
>  seed  =- (long) time(0);
226,255d224
<
< #if DISK
< fprintf(stderr,"disk with radius: %d at x=%d, y=%d\n",
<      RADIUS,XC,YC);
<
< /* opening file with solid */
```

```
<    for(iR=1;iR<1*RADIUS;iR++)
<      {
<       dR=(float) iR/1.;
<       nAngles=(int) (2*PI*(RADIUS));
<       nAngles *= 20;
<       for(iAngle=1;iAngle<nAngles;iAngle++)
<       {
<        phi=(float) iAngle/(nAngles+1);
<        ix=(int) dR*cos(phi*2*PI)+XC;
<        iy=(int) dR*sin(phi*2*PI)+YC;
<        *(solid+iy*nx+ix) = 1;
<       }
<      }
<   fPtrSolid=fopen("disksolid","w");
<     for(iy=0;iy<ny;iy++)
<      {
<      for(ix=0;ix<nx;ix++)
<        fprintf(fPtrSolid,"%d ",solid[iy*nx+ix]);
<      fprintf(fPtrSolid,"\n");
<      }
< #endif
<
<
<
467,473d435
<
<   table[A + B + D + E ] = A + C + D + F;
<   table[B + C + E + F ] = A + B + D + E;
<   table[A + C + D + F ] = B + C + E + F;
<   table[A + B + D + E + EPS] = B + C + E + F;
<   table[B + C + E + F + EPS] = A + C + D + F;
<   table[A + C + D + F + EPS] = A + B + D + E;
```

sukopm@esgdebc /cygdrive/c/Lgapack-0.98/Fhp6_simp
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